LLOYD'S REGISTER STAFF ASSOCIATION

SESSION 1972 - 73

NOTE

DUE TO AN ERROR IN THE ENGRAVING, THE WORDING LLOYD'S REGISTER STAFF ASSOCIATION WAS USED ON THE COVER OF THIS VOLUME. THIS, OF COURSE, SHOULD READ

LLOYD'S REGISTER TECHNICAL ASSOCIATION.

KEYPOINT FRANKE LTD.

a.D.ls.

TRANSACTIONS

OF

LLOYD'S REGISTER TECHNICAL ASSOCIATION

VOLUME 43

1972-3

71 FENCHURCH STREET, LONDON, EC3M 4BS

OFFICERS OF THE ASSOCIATION

President:

A. R. HINSON

Vice-President:

F. H. ATKINSON

Committee:

G. J. BOULTER

J. H. CLUGSTON

P. K. COLES

K. M. B. DONALD

M. S. ESDEN

W. FEARNS

R. A. GOODMAN

R. W. JAKEMAN

D. McKINLAY

J. J. MOTA

E. NICOL

S. G. PRATT

T. E. SHORE

W. F. STOOT (*ex officio*)

T. SWIATECKI

A. WARDLE

D. C. WOOD

Honorary Secretary:

C. CUMMINS

Honorary Treasurer:

J. McCARRON

CONTENTS

Lloyd's Register Technical Association

HULL DAMAGE IN LARGE SHIPS

S. Janzén and O. Nilsson

Paper No. 1. Session 1972 - 73

FOR PRIVATE CIRCULATION AMONGST THE STAFF ONLY

Hon. Sec. C. Cummins
71, Fenchurch Street, London, EC3M 4BS

HULL DAMAGE IN LARGE SHIPS

INTRODUCTION

This paper examines the experience gained operating the more recent larger type of ship and examines the failures that have occurred. The Society for statistical purposes groups together all bulk carriers above 30,000 g.r.t. and all tankers above 50,000 g.r.t. and these groups are conveniently those which are of particular interest for this investigation.

It has been suggested by many reputable sources that inadequate scantlings are the cause of many of the failures on new ships and it is felt necessary to comment upon this, as in point of fact, this is unfair. Viewed in proper perspective the damage reports now being received show that a great deal of progress has been made in the field of ship structural design in the short time that has elapsed since the mid-1960's when the great move forward in the size of ships began.

Not all the failures mentioned in this section of the paper have been on ships that are classed with the Society; others are included, as it is thought that a more general picture will be of particular interest to those people whose day to day work is not directly concerned with the problems associated with ship scantlings, plan approval and survey work. However, where ships classed with this Society are chosen as examples they have been specially referred to. Discussion about the computer analysis, carried out in certain cases, has on principle been avoided. A great deal of work on computer analysis has been published over the last few years, but to be fully appreciated it requires an intimate knowledge of the assumptions that are made, the simplifications that are used for the structural idealisation and the input data. It is impractical in a paper of this type to delve into such a subject for obvious reasons and instead, the failures that have occurred have been concentrated upon with brief comments on some of them.

A lot of publicity was given to failures which were reported by the Japanese in 1970, but on investigation they were found to refer to data which had been published from the reports of damage that had occurred on ships built from 1965 onwards. Some of the larger tankers and bulk carriers of about 60,000 tons dwt. sustained damage in service and also revealed defects in the welding. Furthermore, about a year ago attention was drawn to a number of ships where very heavy corrosion has occurred, over quite a short period of time, in the ballast tanks.

The following are some of the damage and failure cases that occurred. The first, those who took an interest at the time will recall, was damage caused by what was officially described as an "unidentified object" to the shell plating on the starboard side of a 90,000 tons dwt. tanker and this is shown on Plates 1 and 2. In Scandinavia this damage was illustrated by sketches of the type shown on Sketch 1 which appeared in some shipping magazines.

Instances of a similar kind happened on other tankers about the same time and the damage on three ships between 65,000 and 80,000 tons dwt. for which information was available, has been carefully studied and Plates 3, 4, 5 and 6 refer. A typical midship section in way of a transverse web is shown, Fig. 1 where the hull distortion in reasonable weather conditions has been indicated by a dotted line. The damaged area was in way of an empty wing tank where the side shell was set in for 3 m. over a length of about 30 m. Nearly all the cross-ties had

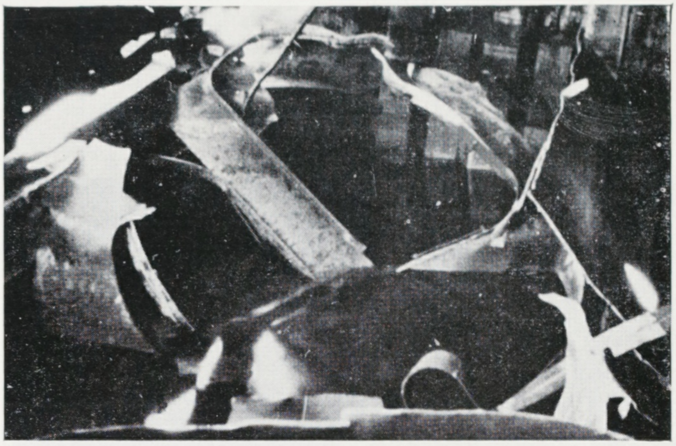


PLATE 1

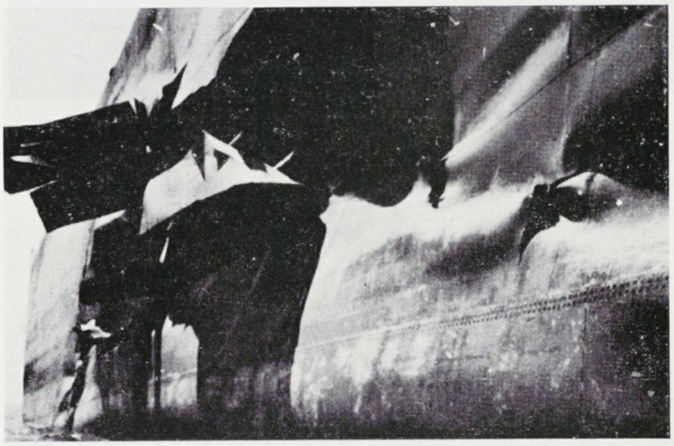
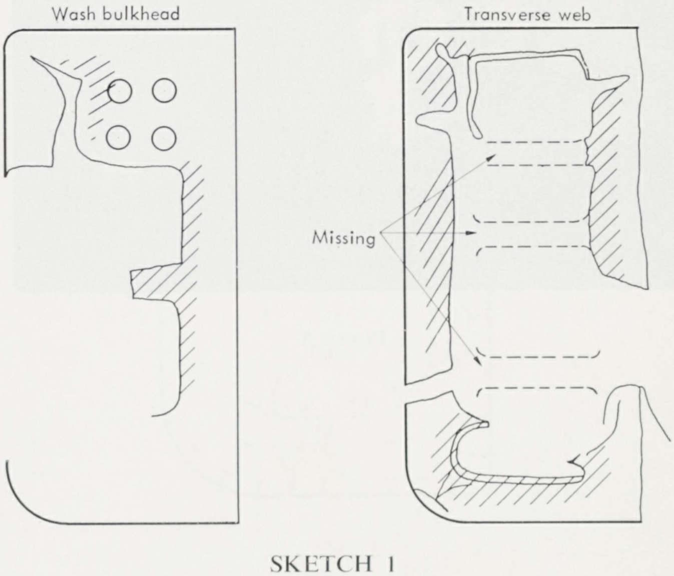


PLATE 2



SKETCH 1

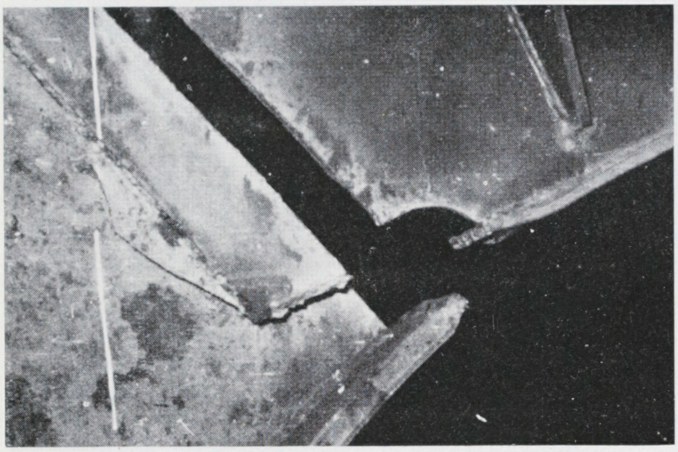


Plate 3

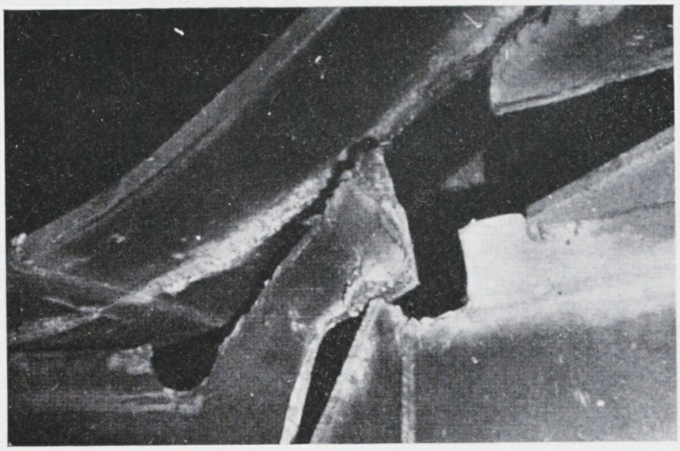


Plate 4

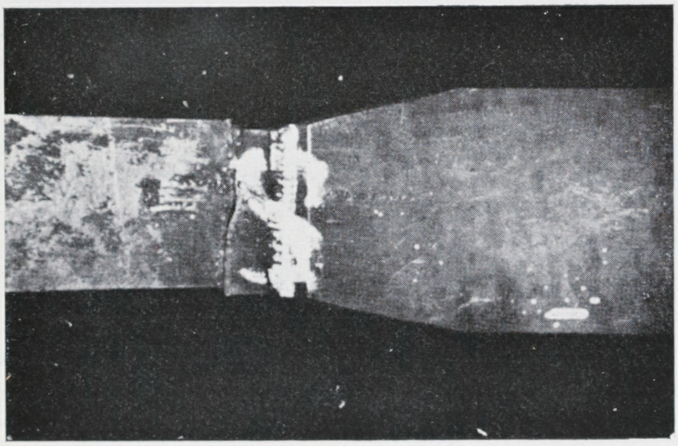


Plate 5

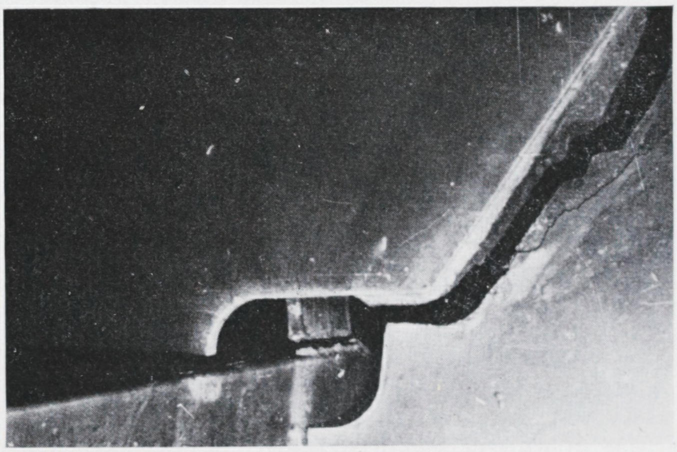


Plate 6

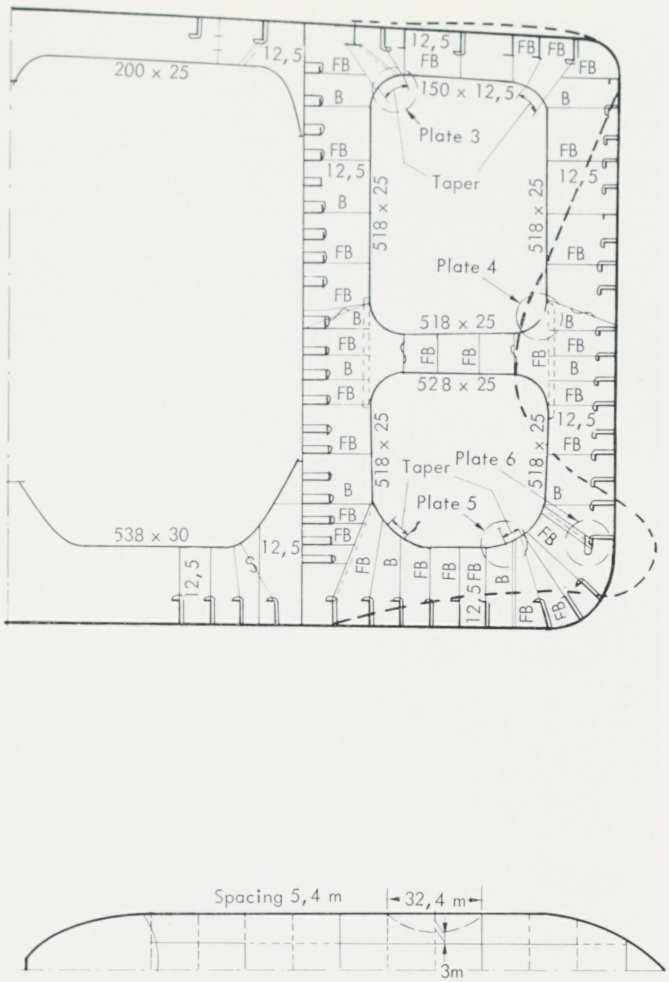


FIG. 1

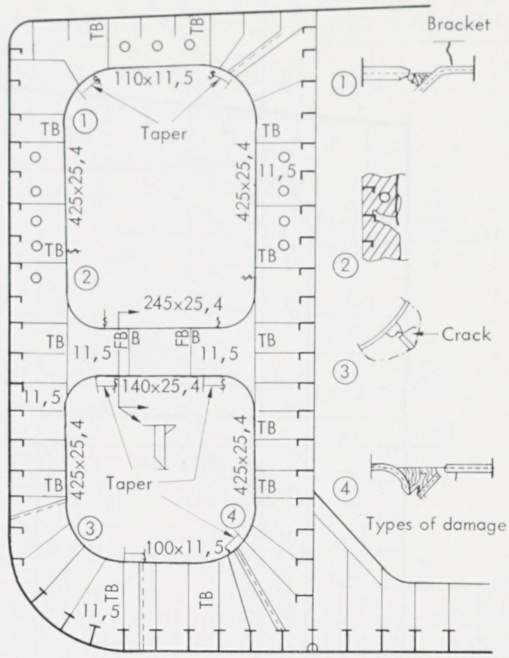


FIG. 2

buckled and broken away at their connection with the vertical web on the longitudinal bulkhead. Consequently the side webs gave way and in some places had completely broken away from the bottom transverse in the wing tank. It should be noticed that in general the webs are only stiffened at every other longitudinal and in Fig. 2 the web frame of another ship is shown where similar damage occurred. It can be seen that the cracking started at the notch cut-outs and it would probably have been less extensive had the use of the notch cut-outs been avoided in the construction. In passing, notice should be taken of the great difference in the sectional area of the face bars to the cross-ties and the transverse vertical webs.

These failures all occurred when the centre tank was full and the wing tank was empty and because the cross-ties had insufficient strength, particularly at the connection with the vertical web, collapse occurred when the combined stress, which included a large shear force contribution, exceeded the yield point.

An indication of the repairs that were carried out is shown in Fig. 3. They consisted of increasing the area of the face bars on the deck and bottom transverses and the cross-tie to give a more even transmission from the vertical web and extending the tripping brackets out to these face bars. Subsequently, stiffeners were fitted at each longitudinal and the

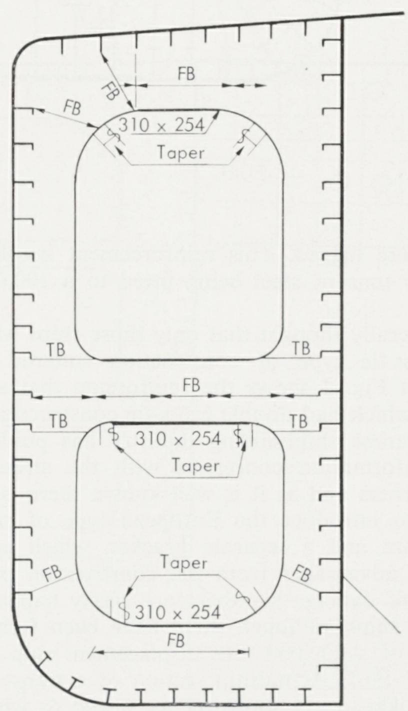


FIG. 3

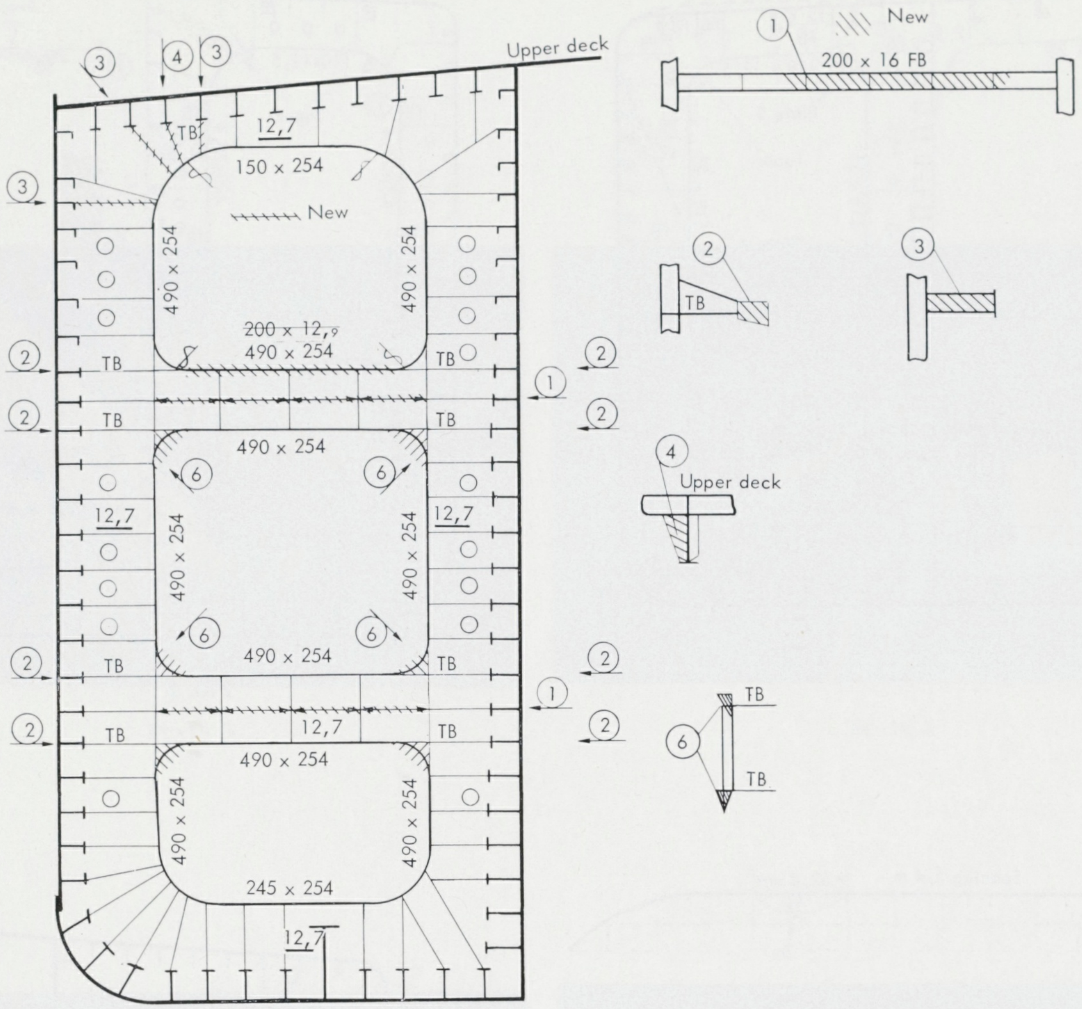


FIG. 4

cut-outs were lugged. This reinforcement involved an extra 300 to 500 tons of steel being fitted to a 100,000 tons dwt. ship.

It is generally thought that only those ships which have the single cross-tie type of construction suffered this sort of failure, but Fig. 4 shows the reinforcing that was necessary on a ship which had double cross-tie construction.

The Japanese shipbuilding industry has published a great deal of information concerned with the stress distribution around corners and as it is well known there is now a trend in Japan to introduce the European type of corner, with a straight joint and a separate bracket, which amongst other things has advantages from the construction point of view. This type of damage has therefore rarely happened in European built ships, although there have been failures. Plates 7 and 8 are of a 200,000 tons displacement ship built towards the end of 1967. A midship section of a transverse web and a wash bulkhead are shown (Figs. 5 and 6) where the small number of stiffeners and the badly placed lightening holes are apparent in addition to the previously mentioned weakness in

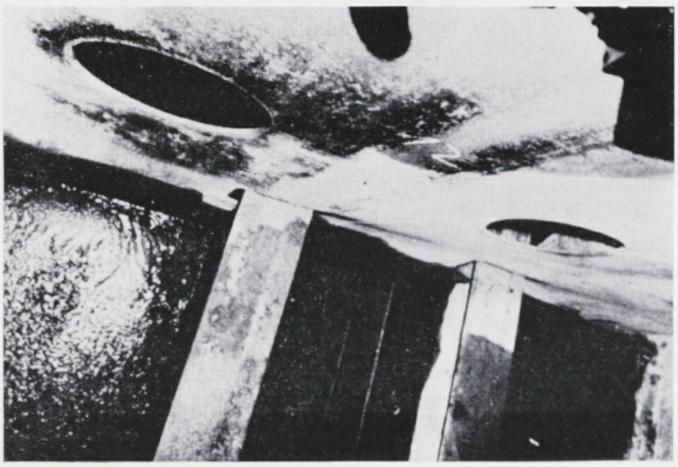


PLATE 7

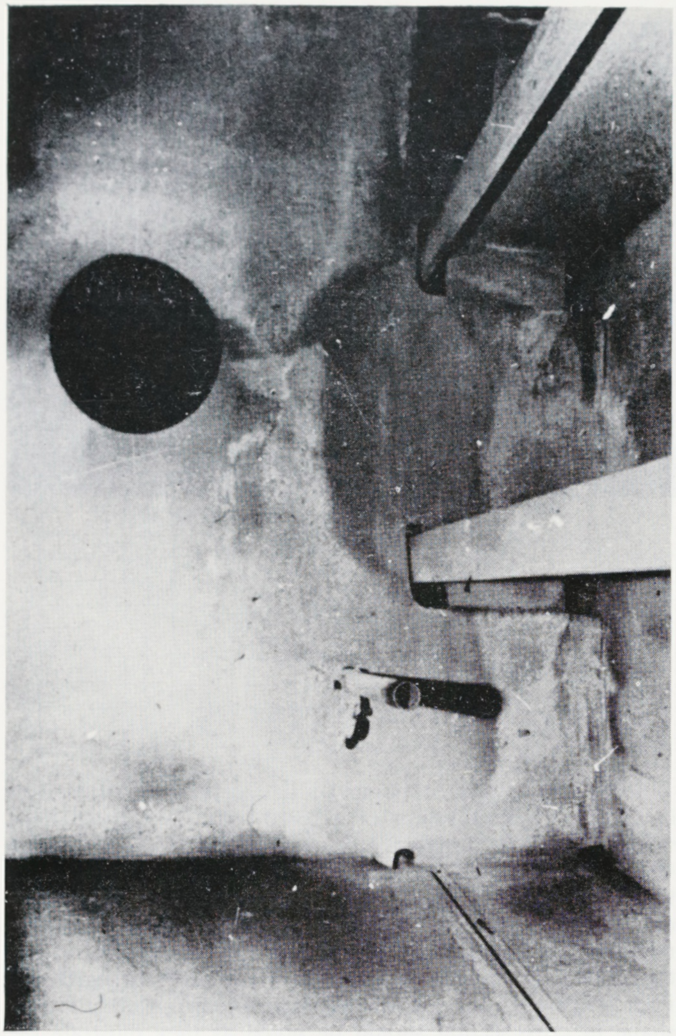


PLATE 8

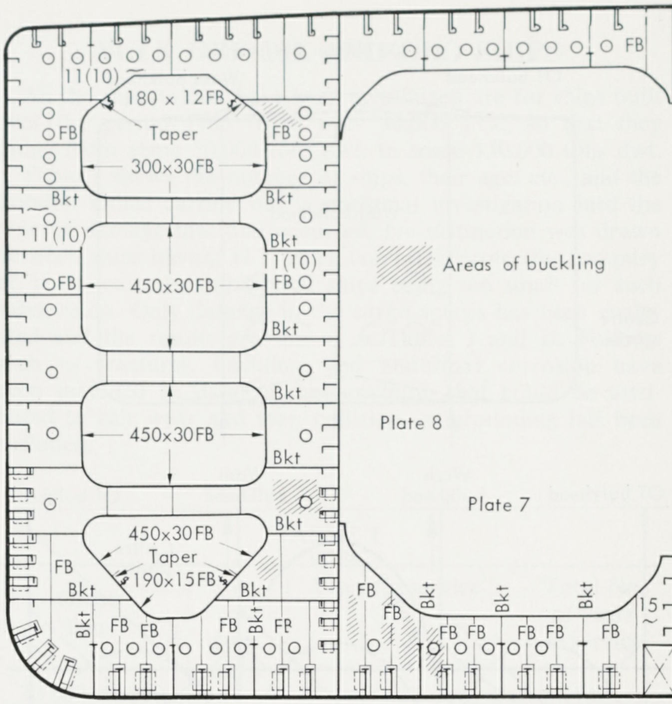
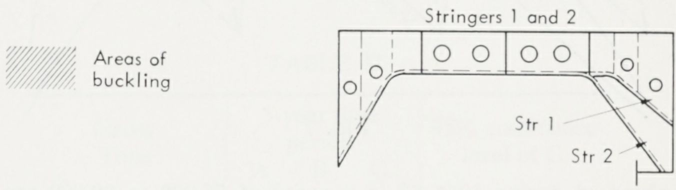


FIG. 5



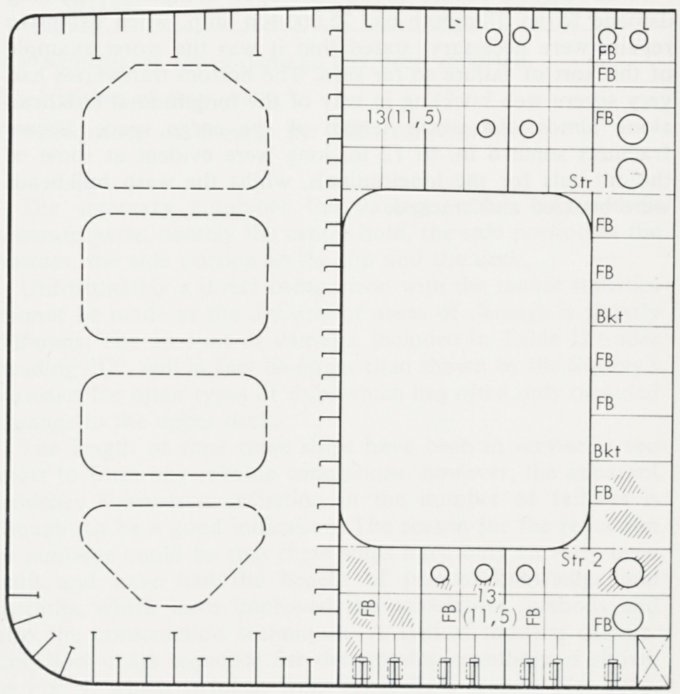


FIG. 6

way of the cross-tie. Fig. 6 also shows the weak wash bulkhead with some buckling damage to the centre line pillar web in conjunction with similar damage to the bottom transverse in the centre tank. The elastic buckling strength for axial pressure was only 150 to 200 kg./cm.^{2} for many of the panels.

Another type of failure that has occurred on European built ships is shown in Fig. 7, which should be compared with Fig. 6. The primary supporting member of the wash bulkhead is distorted, together with the longitudinal bulkhead. The secondary supporting member and the centre girder deflected which in turn deflected the third supporting member—the bottom transverse. In such a sequence of events the stress distribution in the centre girder changes from the theoretical line, shown dotted, to the actual line, shown full.

The centre girder, in theory, is subject to a high bending moment and shear force in way of the oil-tight bulkhead. It will also have a high bending moment at its mid-span between the wash bulkheads. The bending moments and shear forces of the bottom transverses increase at the longitudinal bulkheads and damage occurs most frequently, not in the primary wash bulkhead, but in these secondary members. This was

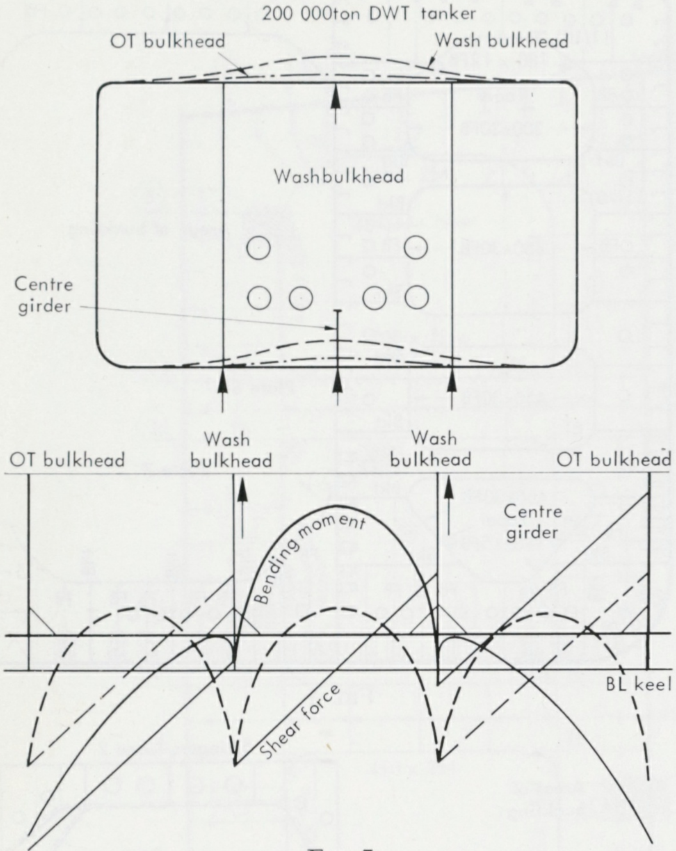


FIG. 7

PLATE 8(b)

observed during 1966–67 in a series of 75,000 to 90,000 ton displacement ships.

A colleague's report to an insurance company regarding damage to an 18-month-old 75,000-ton ship, when extensive repairs were necessary, stated that it was the worst example of this sort of failure so far seen. The bottom transverses had very severe web buckling in way of the longitudinal bulkhead along almost the whole length of the cargo space. Severe fractures some 6 in. to 12 in. long were evident at some of the cut-outs for the longitudinals, whilst the wash bulkheads were buckled and cracked.

Both Japanese and Scandinavian publications report damage in the fore peak to ships of 120,000 tons and 100,000 tons which will not be repeated. However, Fig. 8 illustrates damage which occurred about the same time to a ship classed with the Society on a voyage around the Cape in severe weather conditions. Failure occurred in the vertical web due to large reaction forces emanating from the bottom transverses through the centre girder. The transverses were also damaged and improved support and stiffening had to be arranged and their shape in cross-section should be noted as they illustrate the necessity of a grillage calculation.

Having given a general review the newer, larger types of ships for which information is available will be considered. These ships are all classed by the Society and it should be remembered that some of the ships have only been in service for a short time.

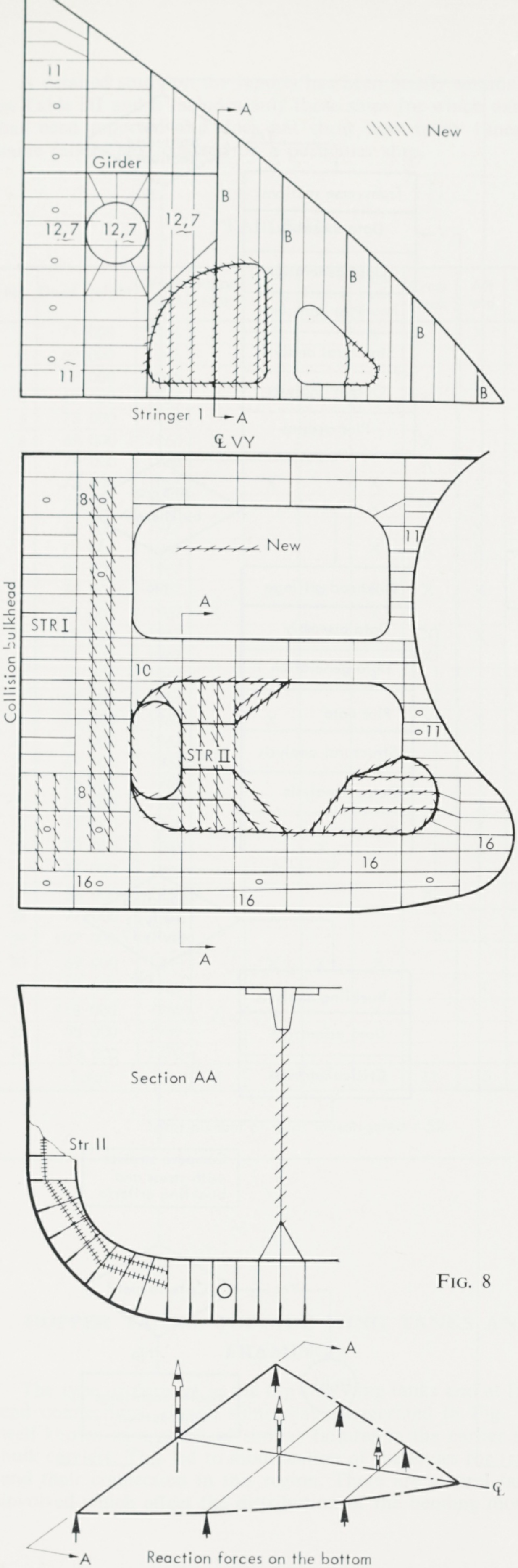


FIG. 8

BULK ORE/OIL AND OBO SHIPS

All the reports that have been scrutinized are for ships built over the period 1965–70 of over 30,000 g.r.t., so that they range from some 50,000 tons dwt. to some 150,000 tons dwt.

Table I shows the number of ships, their age, etc., and the London Office carried out a statistical investigation into the type of damage that had occurred. No distinction was drawn between ships having H.T. steel, corrosion protection, country of build, etc., the number of ships being too small for such subdivision. Only damage in the cargo spaces has been evaluated and the results are shown as Tables I and II. Failures such as fractures, buckling, and abnormal corrosion have been included as damage, but anything that could be attributed to fair wear and tear, collision, or grounding has been excluded.

TABLE I

Gross Tons	No. of ships	Years in service					Total No. of years in service
		1	2	3	4	5	
30 000–49 000	47	47	43	32	18	8	148
50 000–	5	5	4	2	1	–	12

TABLE II

Gross Tons	5-year time period			95% confidence level of C
	A	B	C	
30 000–49 000	42	148	28,4	21,1—38,3
50 000–	1	12	8,3	7,5—40,8

A = Number of times damage has been reported.

B = Number of ship years.

C = Frequency of damage per 100 years' service.

The summary combines the damage which occurred in separate parts, namely the centre hold, the side portion at the bottom, the side portion at the top and the deck.

Unfortunately a direct comparison with the tanker statistics cannot be made as the division of areas of damage is slightly different. The amount of damage, included in Table II under heading "C", will in fact be larger than shown by the Society's statistics for other types of ship, which has often only included damage to the upper deck.

The length of time these ships have been in service is too short to form any reliable conclusions, however, the apparent tendency towards a reduction in the number of failures is thought to be a good indication. The reason for the reduction in numbers could be that these ships have only recently been built and have had the benefit of present knowledge and facilities which have improved the calculation methods and also the construction techniques. A typical modern calculation flow chart sequence for determining scantlings is shown in Fig. 9, which is taken from R. & T.A. Report No. 5081, Ref. (1).

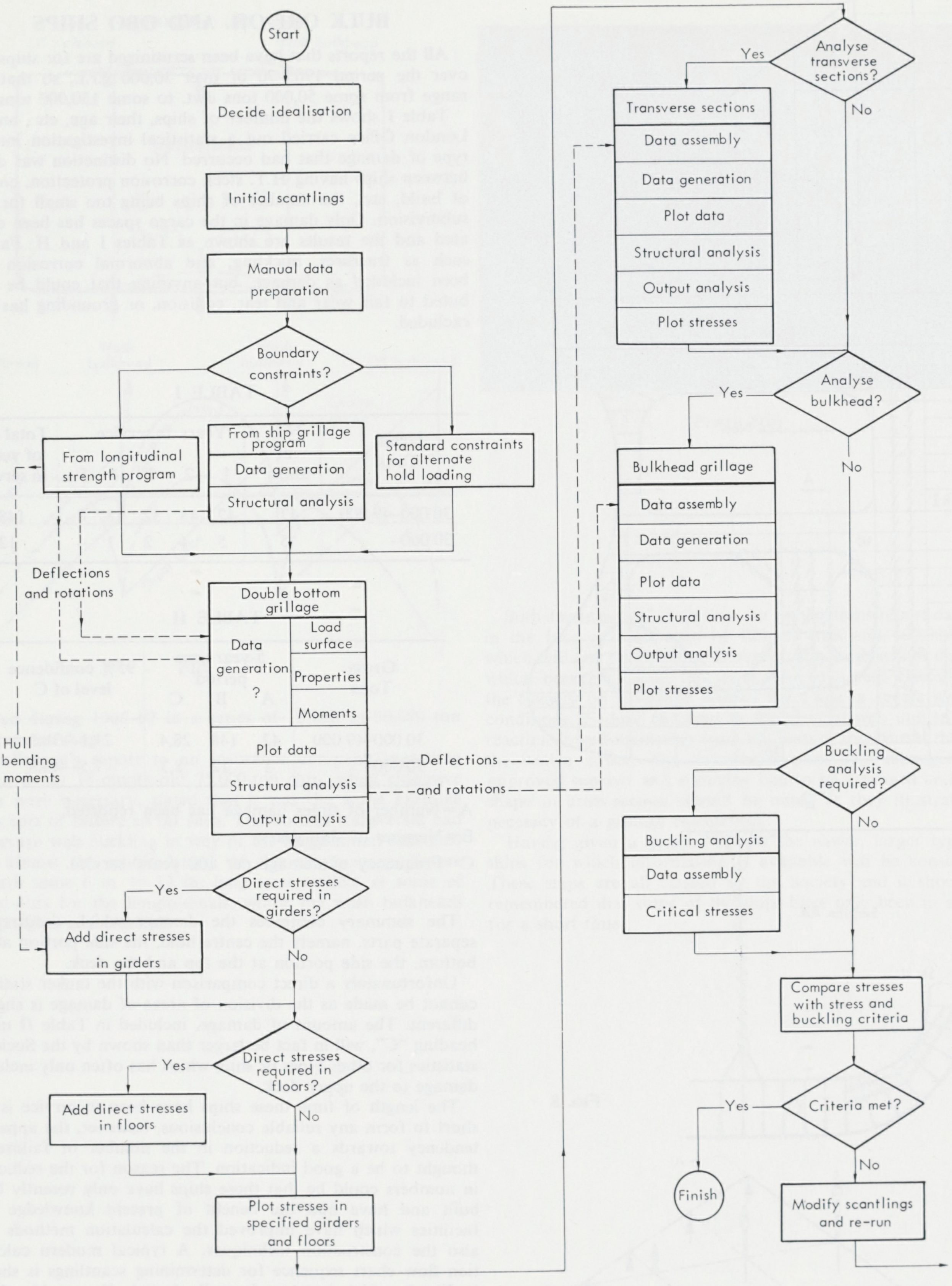

Start
Decide idealisation
Initial scantlings
Manual data preparation
Boundary constraints?
From longitudinal strength program
From ship grillage program
Data generation
Structural analysis
Standard constraints for alternate hold loading
Deflections and rotations
Double bottom grillage
Data generation ?
Load surface
Properties
Moments
Plot data
Structural analysis
Output analysis
Hull bending moments
Direct stresses required in girders?
Yes
No
Add direct stresses in girders
Direct stresses required in floors?
Yes
No
Add direct stresses in floors
Plot stresses in specified girders and floors
Deflections
and rotations
Analyse transverse sections?
Yes
No
Transverse sections
Data assembly
Data generation
Plot data
Structural analysis
Output analysis
Plot stresses
Analyse bulkhead?
Yes
No
Bulkhead grillage
Data assembly
Data generation
Plot data
Structural analysis
Output analysis
Plot stresses
Buckling analysis required?
No
Buckling analysis
Data assembly
Critical stresses
Compare stresses with stress and buckling criteria
Criteria met?
Yes
No
Finish
Modify scantlings and re-run

FIG. 9

A detailed study on the reports has been briefly summarised in Table III and it includes only those ships for which damage has been reported and does not show how many times the same failure has recurred on a particular ship.

TABLE III

No	Dead weight	Year built	Hopper tank	Upper wing tank	Frame	Hold bulk-head	Cross deck	Aft end	Fore end
1	71 000	1965	X	X		X		X	X
2	69 000	1965				X		X	X
3	57 000	1965						X	
4	49 000	1966					X		
5	73 000	1966							X
6	69 000	1966	X				X		X
7	70 000	1966					X		X
8	73 000	1966		X		X		X	
9	72 000	1966				X	X	X	
10	55 000	1967					X	X	
11	72 000	1967				X	X	X	X
12	87 000	1967							X
13	74 000	1967		X	X	X	X	X	
14	74 000	1967	X			X			
15	79 000	1967					X	X	
16	74 000	1967					X		
17	67 000	1967				X			
18	87 000	1967							X
19	75 000	1967		X			X	X	
20	67 000	1967							X
21	67 000	1967							X
22	75 000	1968							X
23	75 000	1968						X	
24	77 000	1968						X	
25	77 000	1968			X			X	
26	57 000	1968							X
27	56 000	1968					X		
28	77 000	1968		X					X
29	107 000	1968						X	
30	69 000	1969		X	X	X			
31	107 000	1969						X	
32	118 000	1969	X	X		X			
33	58 000	1969		X					
34	153 000	1970							X
Total			4	8	3	10	11	15	14
Total number of ships investigated = 52									

HOPPER TANKS, TOP-SIDE WING TANKS AND FRAMING

The type of damage in the top-side wing tanks and at frame end connections, shown somewhat exaggerated in Fig. 10 is well known as a result of similar failures in the earlier small bulk carriers. This led to modification of the Rules for frames and their connection in this region. There are several factors involved which affect the distribution of the bending moment and shear force in the frames and at their connections such as the aspect ratio of the hold, the loading on the tank-top and side shell, and the stiffness of the hopper and the top-side wing tanks. The stress distribution varies a great deal due to these factors. In the conventional dry-cargo ship the conditions are much simpler as the frame bilge brackets are generally only subjected to compression and can normally be accepted without further investigation. However, on the ships under consideration the performance in the "frame-wing" tank area has been satisfactory. The frame is usually of the web type with intermediate ordinary frames which, naturally, have less stiffness. This method of construction has been criticized on this account by certain builders in Sweden, but although this is not substantiated by adverse performance of the ships now investigated, some extra tripping brackets to the webs connecting the adjacent frames may be necessary at the end in each hold that is intended should be used for water ballast. The transverses in the tanks show no signs of buckling as a lot of attention is now given to torsion and web plate buckling.

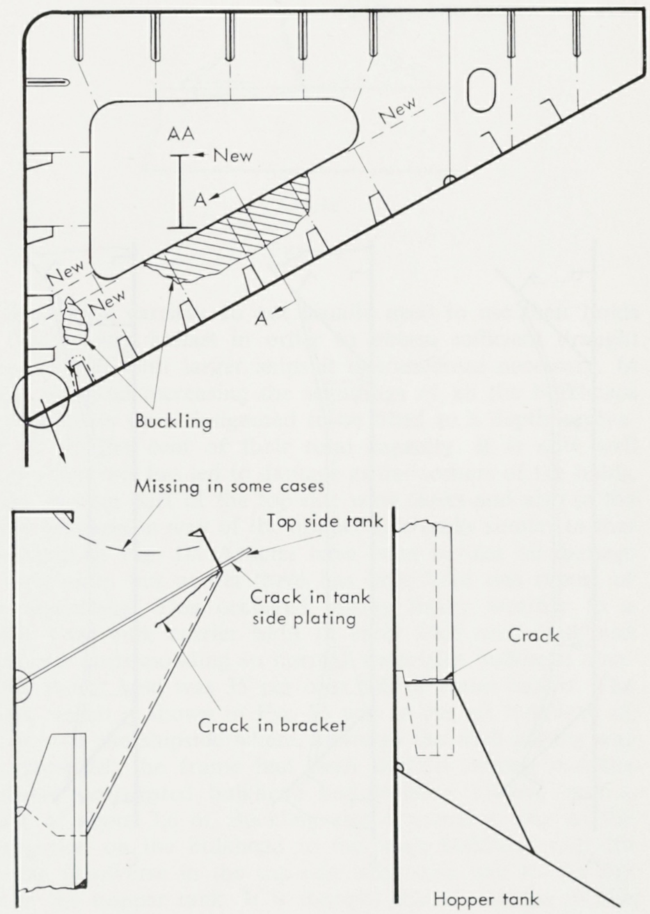


FIG. 10

The different types of end connection to frames are shown in Fig. 11. "A" appears to be the best arrangement, although it has not shown itself to be superior in service to arrangement "B" which has a separate frame-bracket, instead of the well rounded connection shown on "A". One reason for this could be that the frame brackets are not in line with the tank transverses, as correct alignment may be difficult. Another is that the frame face flat is not sufficiently tapered. By far the greatest number of ships have connections as arrangement "C" with a horizontal stringer plate at the bottom of the top-side wing tank and this sometimes causes trouble with sloshing. The tank bottom arrangement for both "A" and "B" can lead to drainage difficulties causing corrosion of the tank plating.

Examples of bending moment and shear force distribution are shown in Fig. 12(1). It should be remembered that a small deformation also occurs at the top of the top-side wing tank itself and if brackets of the type shown in Fig. 13 are fitted, they must be properly stiffened or they may buckle as happened in one particular case.

Other defects that occur in the tanks are of a minor nature, such as the occasional crack in the connection between the sloping wing tank side and the transverse bulkhead brackets which are welded to an unstiffened area of plating, due to misalignment, etc. There are also the cracks in way of the intersections of the top and bottom tanks with the end bulkheads (engine room-peak) where horizontal and vertical members run across one another.

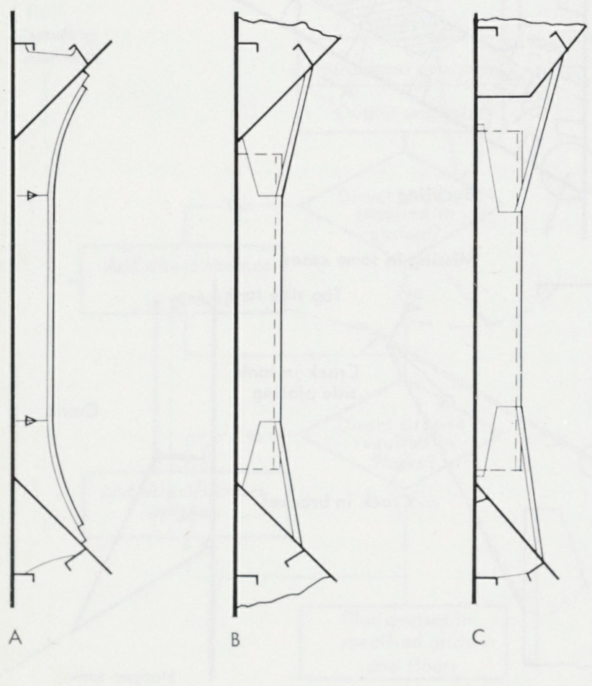


Fig. 11

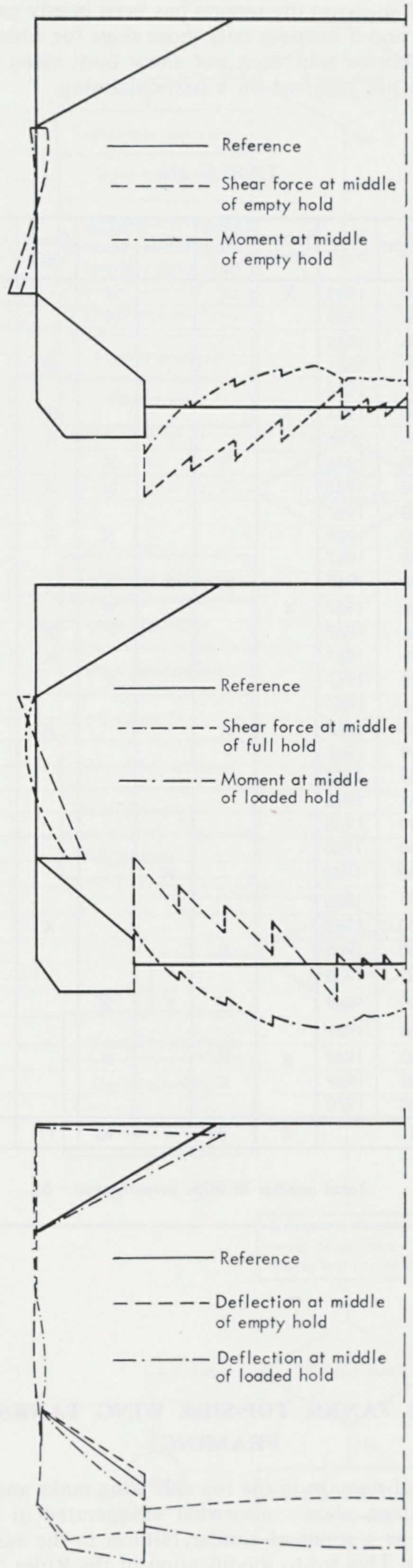


Fig. 12

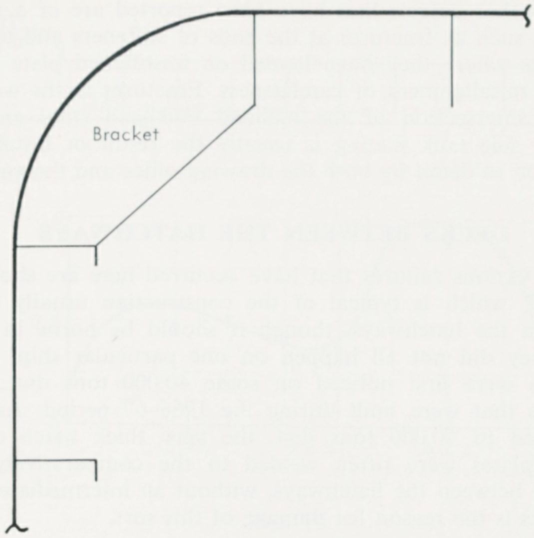


Fig. 13

CARGO HOLD BULKHEADS

The bulkhead failures reported on OBO type ships are usually the result of carrying water ballast. In holds used as tanks, bulkheads are usually of vertically corrugated construction with top and bottom stools. This form of construction is also used on conventional bulk-carriers, but the bottom stools are not always fitted and damage has been reported on one such ship when the hold was partially filled with water ballast. No grave defects have been reported on OBO ships, although one ship of 70,000 tons with horizontally corrugated bulkheads had them stiffened with large vertical webs. Plate 9 indicates cracking at the web prior to modification. The configuration of the bulkhead is shown by Fig. 14 and the dotted line indicates the deformation caused by alternate hold loading. It should also be noticed in passing that the deck beams between the hatchways run transversely and that even this factor, together with the horizontal corrugations, did not prevent cracking of the type which will be elaborated upon under the heading "Decks between the Hatchways".

Plate 9

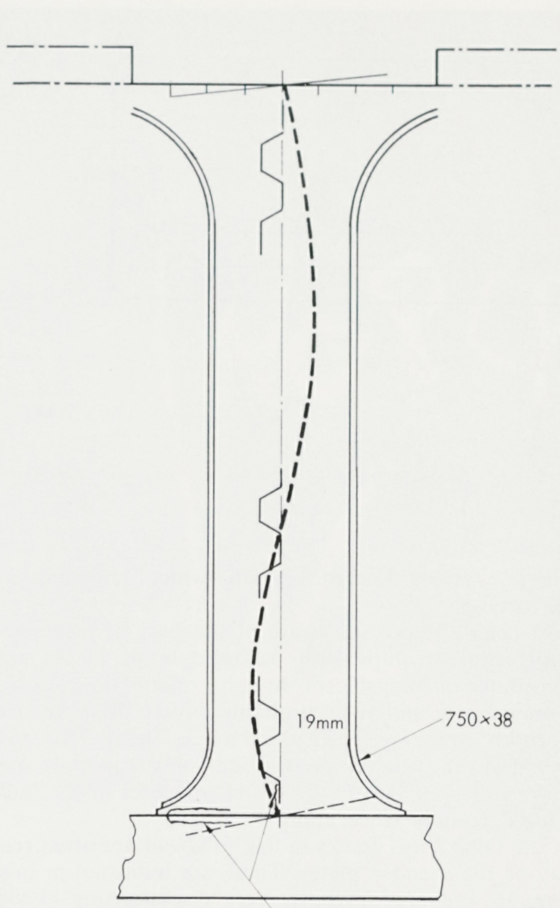


Fig. 14

Small bulk carriers do not usually need to use their holds to carry water ballast in order to obtain sufficient draught forward, but with larger ships it is sometimes necessary. In order to avoid increasing the scantlings of all the bulkheads specific holds were designated to be filled to a depth equivalent to 25 per cent of their total capacity. It is now well known that this has led to damage at the corners of the holds, to the bottom part of the top-side wing tanks and also to the frame brackets in way of the hopper side tanks similar to that illustrated in Fig. 10. Articles have been written on damage to bulkheads, but as yet there has only been one report of this happening. This occurred during heavy weather to a 70,000 tons bulk carrier built in early 1969 with bulkhead scantlings corresponding to normal watertight bulkhead standards. No. 3 hold was 35 per cent full of water ballast. The failure which is shown in Fig. 15 was to the aft bulkhead of the hold at the shipside where, although the shell plating was not damaged, the frame had been slightly twisted and the vertically corrugated bulkhead had buckled 15 cm. over a length of about 3,6 m. Buckling also occurred in way of the corrugation on the bulkhead to the wash bulkhead and the flat bar transverse in the top-side wing tank and to the flat bar in the hopper tank. It is thought that the design of the top-side wing tanks probably contributed to the limitation of the damage to the extent of it being considered only a minor failure, but it was surprising to find that the frames and the

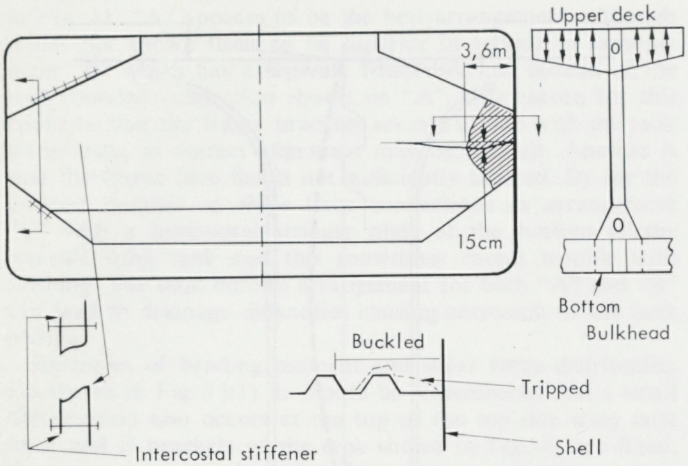


FIG. 15

stiffeners were of Holland profile which has only limited lateral strength.

Most people today are aware of the risks of resonance and the operation of ships with ballasted holds places a heavy responsibility on the officers. In spite of the ability to predict ship movements and their probable effects (Ref. 2), partially filled holds are rarely suggested these days. This may be partly due to the Society's restrictions on the permitted operating levels of water in the hold and increases in the bulkhead scantlings required when approving plans.

On the OBO ships cracks in the bulkhead are often reported in way of the sheddar plates. These are indicated in principle on Fig. 16 and are obviously very disconcerting in view of the problems associated with gas freeing. Another recent problem is lamellar tearing of the shelf and tank top plating occurring at points B, C, D and E.

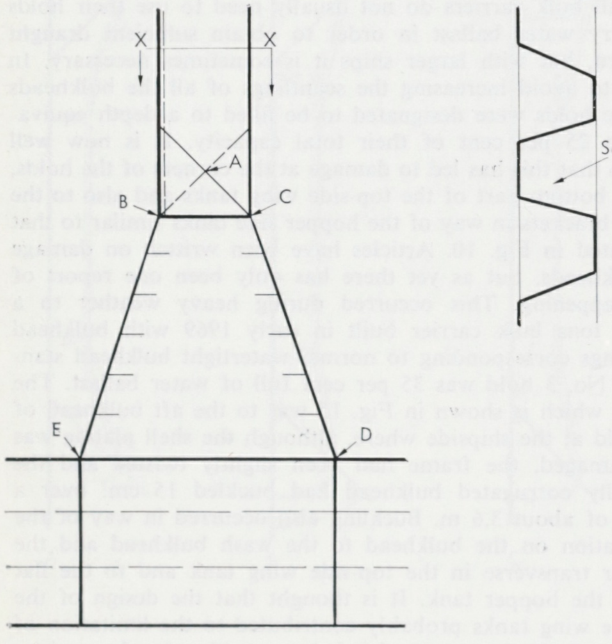


FIG. 16

The other defects that have been reported are of a minor nature, such as fractures at the ends of stiffeners and toes of brackets where they have landed on unstiffened plate either due to misalignment or carelessness. Fractures in the welding at the intersection of the inclined bulkhead stool and the hopper side tank plating is usually the result of insufficient attention to detail by both the drawing office and the yard.

DECKS BETWEEN THE HATCHWAYS

The various failures that have occurred here are shown in Fig. 17, which is typical of the construction usually found between the hatchways, though it should be borne in mind that they did not all happen on one particular ship. These failures were first noticed on some 40,000 tons dwt., bulk carriers that were built during the 1966–67 period. As sizes increased to 70,000 tons dwt. the very thick hatch corner insert plates were often welded to the comparatively thin plating between the hatchways, without an intermediate plate and this is the reason for damage of this sort.

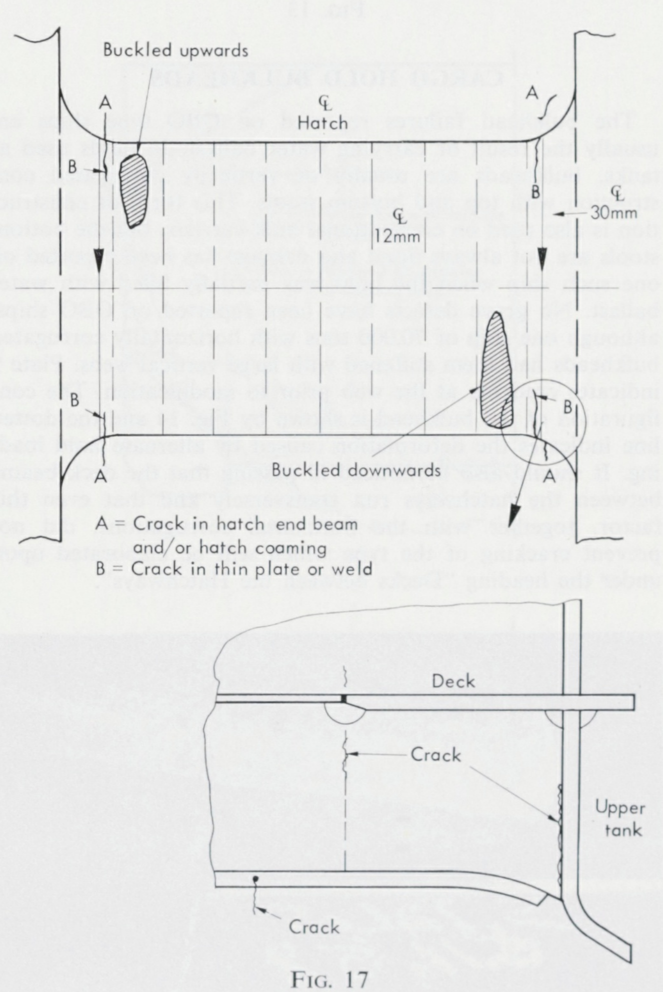


FIG. 17

A study of the relative distribution of failures over the cargo spaces for this type of ship shows that the hatch covers of No. 2 and No. 3 hold were invariably mentioned and the remaining failures were spread roughly as indicated in Fig. 18 showing that the greatest risk of damage is about the forward

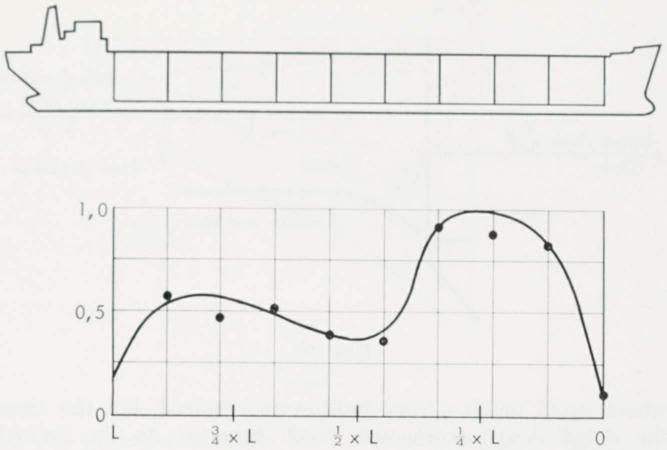


FIG. 18

and after quarter length. Too much should not be made of this conclusion as the figures used were based on a rather small sample (*see* Table III).

Two ships which had fractures in the deck plating between the hatchways also had fractures in the hatch cover side plating similar to those that are mentioned later with container ships.

The importance of designing hatch end beams so that an even stress flow is obtained in the transverse direction across the ship is emphasized, especially where it joins into the top-side wing tank. The difficulties of doing this satisfactorily with a 3 in. round bar should be appreciated as the consequences of not doing so are shown in Plates 10 and 11.

Severe cracking occurred when for production reasons the hatch end beam, the hatch end coaming and the butt in the deck plating were all in the same line. It would appear that fitting a top stool to the bulkhead is a way of obviating this sort of failure. Present-day ships have plating of intermediate thickness introduced in this area together with transverse beams and even the hatch end coaming in some instances has a horizontal stiffening. The failures that occur are often attributed to the deflection of the transverse bulkhead in its own plane due to the very large downward forces which happen in alternate hold loading conditions together with transverse compressive stresses in the deck. All this is very easy to prove mathematically, but there are other factors involved, which have been previously mentioned, one being hatch end beams fracturing at their connection with the top-side wing tank, indicating tension. A London Office colleague explained this by the fact that up until now most of the bulk carriers were built to use the Panama Canal and had a beam of some 32,3 m. but with the advent of 150,000 tons dwt. vessels having beams of some 48 m. to 49 m. they now have to sustain increased torsional moments, without a corresponding increase in the resistance of the structure formed by the double bottom, hopper side and top-side wing tanks. The decks between the hatchways are, therefore, subjected to higher stresses as they hold both sides of the ship together and the design details of the hatch end coaming and the hatch end beam, forming the flanges of this member, should therefore be carefully examined, together with the shear stress in the deck plating.

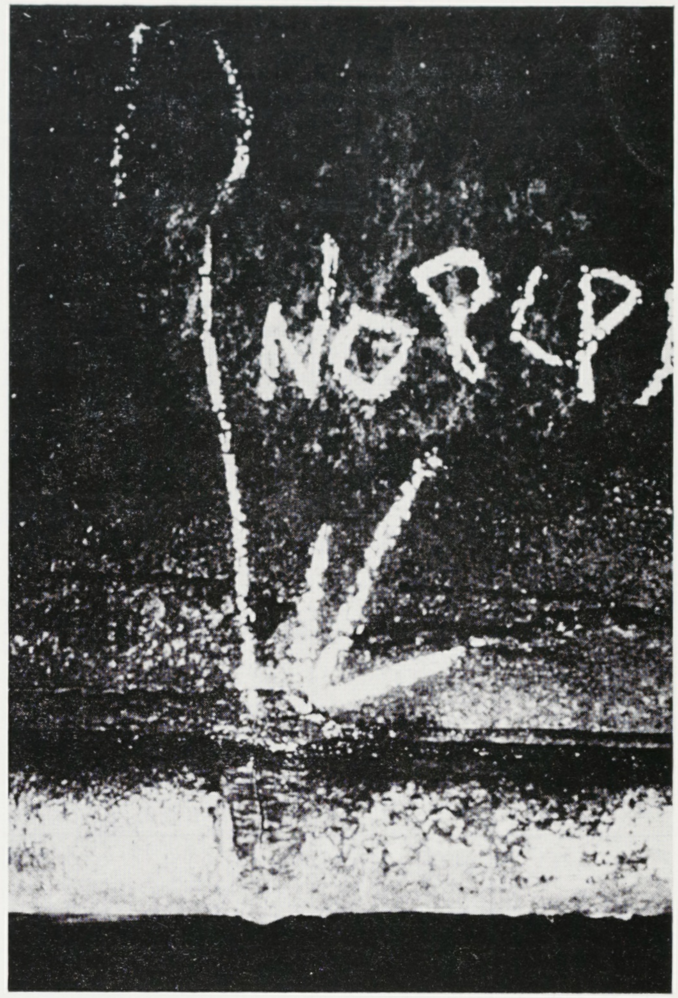


PLATE 10

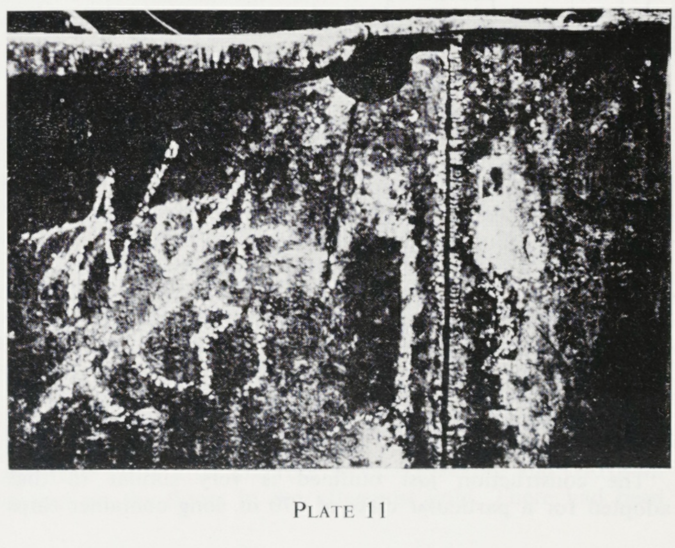
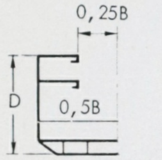
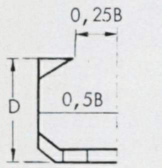
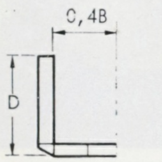
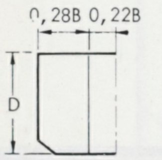


PLATE 11

A simplified comparison of the torsional properties of various types of ship has been made by another London Office colleague and is reproduced as Table IV. The ships all have the same principal dimensions, with a length of 150 m. and a deck opening of about 0,7 L without any cross-decks or struts. The relative values with regard to movement and stress indicate the importance of the cross-deck between the hatchways.

TABLE IV

TABLE IV	Thickness (cm)	$\frac{\varepsilon}{D}$	Hydro-static torque	Warping displace-ment ratio	Stress ratio
	2,42 1,0 2,1 1,8	-1,075	1,02	1,60	1,09
	2,264 1,2 2,1 1,8	-0,1	1,0	1,0	1,0
	3,065 1,5 2,1 1,8	-0,83	0,95	0,55	0,76
	1,45 1,8	+0,88	0,45	0,0064	-

One type of cross-deck construction between the hatchways with poor transverse continuity is shown in Fig. 19, where the idea behind the design was to relieve, or considerably reduce, the necessity for having radius corners on hatchway openings, by reducing the constraint offered by the cross-deck. The scheme was tried on three ships which had hopper, side wing and top-side wing tanks together with a continuous hatch coaming. The fractures that occurred are indicated and many different modifications were tried, including transverse brackets and horizontal gusset plates in attempts to stop the cracking, but without success. In the end the cross-deck on some of the ships was altered with radius corners inserted in the hatchways.

The construction just outlined is very similar to that adopted for a particular class of 170 m. long container ships

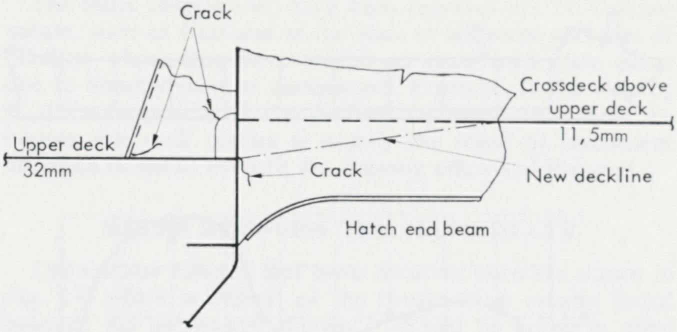


FIG. 19

where small hatch corner radii were required, but this time the detail design work was much superior. In the limited period of service so far the performance of the structure has been satisfactory.

AFT END

Vibration is usually quoted as the cause of most of the fractures occurring in this region as they happen not long after the ship enters service. From reading the reports this is thought to be a reasonable conclusion. Examination of a group of ships revealed that 11 had failures in the region of the aft peak, seven in the engine room, and two in the superstructure. The most common of all those that occurred in the aft peak were at the connection between the floors and the shell, where it is difficult to weld and inspect due to the slope of the shell. Difficulties also arise in way of the shell in obtaining a good end connection of the stiffeners on the aft peak bulkhead and for this reason the bulkhead plating in this region is often required to be thicker in an attempt to compensate for this possible deficiency.

The centre-line bulkhead should have a stiffener at each frame, be well connected to the adjacent structure and, where beams pass through, they should be double lugged. The length of stiffeners that are fitted should be as short as possible and on no account exceed 5 m. as this would appear to produce difficulties in service. The reduction in length can be obtained by fitting intercostals between every two adjacent stiffeners, leaving every second bay free thus avoiding creating an ordinary load-carrying stringer. The types of end connection for stiffeners, shown in Fig. 20, should not be used as smooth-faced bracket connections are required.

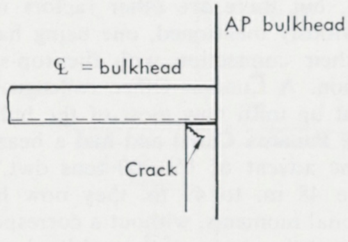


FIG. 20

The floors in way of the rudder horn and forward of it should be specially considered for stiffness as Fig. 21 shows an arrangement where excessive vibration occurred in this part of the ship. Fractures started in the connection of the

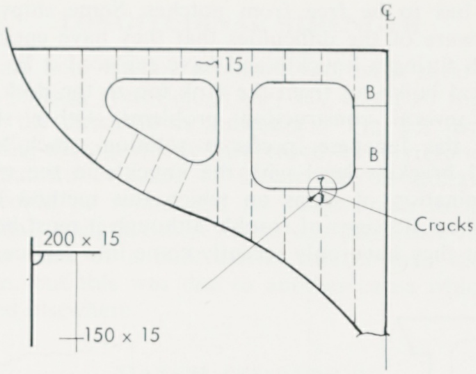


FIG. 21

flat bar stiffeners with the 200 x 15 mm. flange to the floorplate which also cracked and was badly corroded. A big improvement was made by reducing the opening in the floorplate, although an extra longitudinal bulkhead would have been much better. It is possible to reduce the influence of the added mass by increasing the lightening holes, but before doing so, the strength of the member must be carefully investigated.

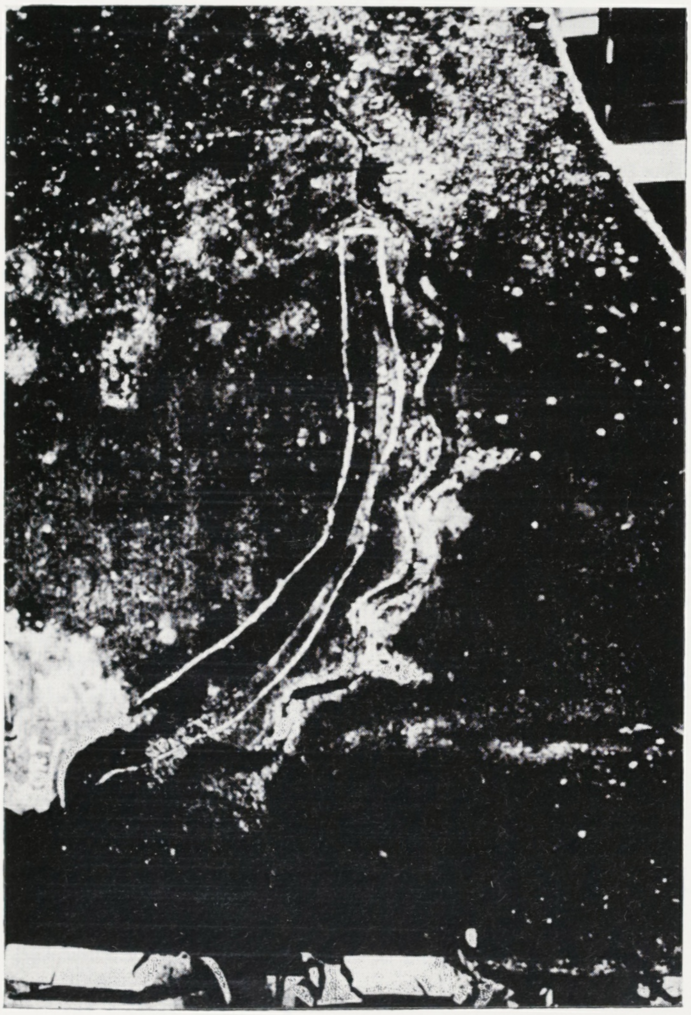


PLATE 12

Fractures have also occurred in the weld connection of the sternframe to the shell at the bottom of the aft peak after ships have been in service from eighteen months to three years. Back runs are shown to these welds on the plan, but they were very difficult to lay as can be seen from Plate 12. This wave profile fillet weld type of construction is no longer used, except on some runners, even though an increased length of connection is obtained.

Another type of fracture that has occurred is shown in Fig. 22 immediately forward of the aft peak bulkhead where the frame spacing changes, with consequent change in plate stiffness. It is recommended that the plate thickness be increased locally and the fitting of extra horizontal stringers should be considered.

Welding of the sea water inlets to the shell plating seems to require attention as there have been reports of cracks occurring even when there has been no reported vibration in the aft end.

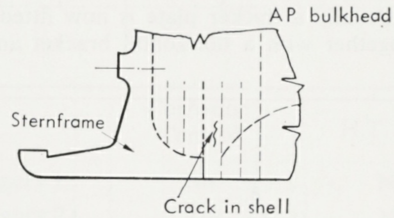


FIG. 22

FORE END

Most of the failures that have been reported have been concentrated about the forecastle deck, with the rest in the bow and side shell plating, though for tankers the reverse is the case, however, the failures are very similar for both types of ship.

The weakest part of the forecastle deck supporting structure are the pillars and estimating the collapse load for each individual failure reveals that before 1967 the head was about 5 m. whereas ships built after that date, when new rules were introduced, have a collapsing head of about 12 m.

DOUBLE BOTTOMS

It was expected that there would be reports of buckling damage on the moderately thick plate longitudinals which previously had often been vertically stiffened with large manholes. It was something of a surprise that none could be found, but it should be remembered that the later ships have the benefit of increased scantlings as a result of the improved methods of calculation that are now available. However, records of earlier, smaller dry cargo ships have also been examined and even here the plate longitudinals were found to have been satisfactory.

One failure which did occur in a bulk carrier was at the juncture between the double bottom and the hopper tank, the construction of which is shown in Fig. 23. Between three and four years after entering service, cracking and corrosion started on the floors in the aftermost hold. There had been

earlier damage at the stern which may partly explain this, but the structure is unsuitable as already has been stated in the introduction (*see* Figs. 2 and 3).

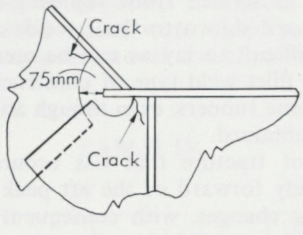


FIG. 23

WING TANKS

The remarks will be confined to drawing attention to the knuckle which sometimes exists on ore/oil ships shown on Fig. 24. Stress concentration in this corner can lead to small cracks occurring and today such knuckles are specially considered, especially if the lower part of the bulkhead has a large slope. Usually a thicker plate is now fitted, possibly of H.T. steel together with a horizontal bracket and the whole structure has to be free from notches. Some shipyards are now so aware of the difficulties that they have entirely done away with fitting a knuckle and have replaced it by a sloped longitudinal bulkhead from the tank top to the deck, thereby avoiding several construction problems. Other shipyards, especially the Japanese, prefer a solution which has large horizontal brackets level with the knuckle in the wing tank and examination of ships on which this method has been adopted show no signs of trouble although it must be remembered that they have only recently come into service.

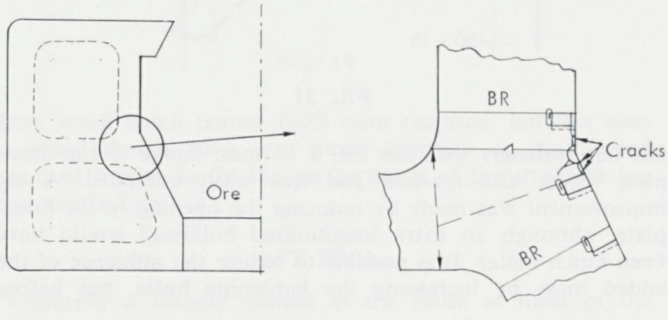


FIG. 24

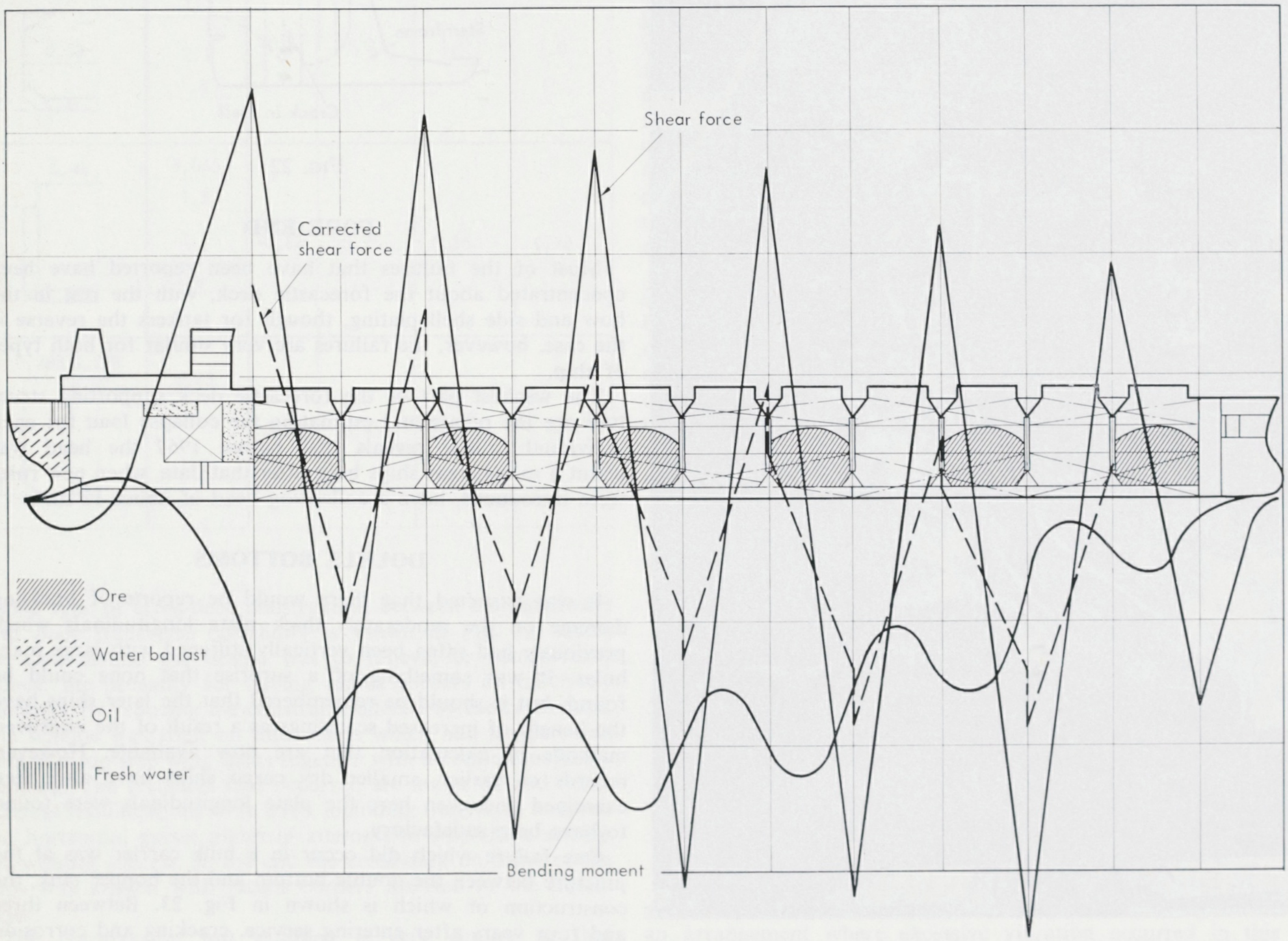


FIG. 25

LONGITUDINAL STRENGTH

Alternate hold loading produces very large shear forces in the shell plating, even though they are corrected for the load taken by the bulkhead as indicated in Fig. 25. Incidence of shell plating damage due to this reason was therefore carefully sought, but no evidence of failure due to excessive shear stresses could be found and no failures due to insufficient longitudinal strength either. There was a fracture reported in the upper deck of a bulk carrier smaller than those under discussion, but this was due to another cause which will be mentioned elsewhere.

HATCH COAMINGS

Hatch coamings are often not continuous and normally made of mild steel, even though the deck is constructed using H.T. steel, and this arrangement has worked well. However, on one 75,000 tons bulk carrier a fracture has occurred in the coaming of No. 5 hold which started at the end of a horizontal intercostal stiffener and travelled upwards to the hatch coaming flange. Although an isolated incident, when considering the stress levels to which these relatively long stiff coamings are subjected, it should be remembered that good detail design and workmanship is important even in this area.

The plans or hatch coamings are usually examined and approved in principle, but the stress distribution that has been assumed can be vastly altered if modifications are made to the design afterwards, to enable control gear and hatch battening arrangements to be fitted.

TANKERS

Surveyors' reports on all tankers of over 50,000 g.r.t. which corresponds to ships of over 100,000 tons deadweight, classed by the Society have been studied.

GENERAL STATISTICS

Before going into detail on the actual failures it is thought that it will be of interest to review the results of a General Statistical Analysis which was carried out by London Office early in 1971 at the request of the Authors.

This gives a more general picture of the performance in service of tankers against the following criteria: —

(i) Damage reported in tankers built during the period 1960–69.

(ii) Distribution of damage amongst ships built in different countries which are given in Table V. This was requested in order to give some background information only and will not be elaborated upon.

(iii) Three groups, broken down in size, were studied. The sizes and actual percentage of the world tanker fleet are shown by Table VI.

(iv) Separated into groups using H.T. steel and/or corrosion control or neither (*see* Table VII).

(v) Only damage to the following component parts was considered: —

(a) Centre tank.

(b) Wing or side tanks.

(c) Main deck.

TABLE V

Ship 50, 000 BRT and bigger

Country of build	Type	Number of ships	Years in service 1	2	3	4	5	6	Total of years in service
Great Britain and Northern Ireland	1	4	4	4	4	3	2	1	18
	2	4	4	4	3	3	1	1	16
	3	4	4	2					6
Scandinavia	1	4	4	4	2	2	1	1	14
	3	8	5	1	1				7
	4	1	1						1
Europe	1	12	9	5	3	2	2	1	22
	2	1	1	1	1	1	1		5
	3	6	5	1					6
	4	3	1	1	1				3
Japan	1	4	3	2	2	1	1	1	10
	2	2	2	2	2				6
	3	13	8	3					11
	4	3	2						2
		69							

Explanation

	Corrosion Control	H.T. Steel
Category 1	No	No
Category 2	Yes	No
Category 3	Yes	Yes
Category 4	No	Yes

TABLE VI

Gross Tons	Approx. Deadweight	% of world tanker tonnage: Year of build 1960–64	1965–69
7 000–29 000	10 000–50 000	39%	50%
30 000–49 000	50 000–100 000	34%	31%
> 50 000	> 100 000	21%	32%

TABLE VII

Corrosion Control	H.T. steel: Yes	No	All
Yes	12,4	15,8	14,6
No	13,4	21,2	20,9
All	12,7	20,4	19,5

TABLE VIII

Gross Tons	No. of ships	1st five-year survey A	B	C	2nd five-year survey A	B	C
7 000–29 000	231	148	958	15,5	141	531	26,5
30 000–49 000	144	125	615	20,4	41	141	29,1
> 50 000	24	17	59	28,8	—	5	—

A = Number of times damage has been reported in the centre tank, wing tank, side tank and main deck.

B = Number of ship years.

C = Frequency of damage per 100 years' service.

Some general comments are given with respect to ship size, length of time in service, year of build and various reported defects. Column "C" of Table VIII shows the tendency for them to be slightly more vulnerable to damage with increase in size.

It should be noted that the difference in the occurrence of damage between the 30,000–49,000 tons group and the 50,000 tons and above group is not statistically significant as the service time of the larger ships is quite short. The significant constructional differences between the groups of different size should be remembered when studying these figures.

Ships of up to 50,000 g.r.t. seem to have a higher incidence of damage at their ten-year special survey compared with their five-year survey. Within the first five-year period the peak in failure occurrence comes during the first two years when most of the initial failures are reported and repaired. The influence of year of build is shown on Table IX (Summary of Tankers) and it indicates that large ships built during the 1965–68 period are more prone to damage than any other group, a fact which has been stated earlier. The statistics also show that the occurrence of damage on tankers of 7,000–29,000 g.r.t. built 1960–64 and 1965–69 respectively, were nearly the same over the first five years of service.

A significant variation of damage could be seen within the groups of small ships built in certain countries, but no such indication could be found for the larger ships.

TANKERS WITH OR WITHOUT H.T. STEEL AND OR CORROSION CONTROL

It is difficult to obtain any significant indication from the statistics due to the short length of time the ships of the different groups have been in service. The results of all the ships of over 30,000 g.r.t. are therefore combined and presented on Table VIII. The table shows damage occurrence for tankers over 30,000 g.r.t. for 100 years of service, over the first five years. Too many conclusions should not be drawn from this table as the service of some of the ships is rather short, in the four groups considered. However, the table does indicate that the use of H.T. steel and/or corrosion control has at least given a relative decrease in the number of failures reported. H.T. steel has until now usually been used at the deck, sheerstrake and bottom shell and the experience gained with this particular application does not necessarily apply to internal members such as transverse rings which are subjected to large dynamic forces and possibly larger stress concentrations also.

TANKERS OVER 50,000 G.R.T.

As mentioned earlier, the intent of this paper was to concentrate on ships of over 50,000 g.r.t. broken down into categories and years of service which are set out in Table V. During study of the reports a simplified summary of ships, on which damage had been reported, was prepared and is given as Table IX. This is similar to the table which was prepared for bulk carriers together with comments on the failures.

TABLE IX

Tankers 90 000 DWT

No	Year built	DW	Engine horse power	Diesel	CC	HT Steel	Fore end	Aft Peak	Machinery Space	Transverse Ring		Longitudinal Girder		OT Bulkhead		Wash Bulkhead
										Side	Centre	Side	Centre	Transverse	Longitudinal	
4	1963	95 000	27 000							X				X		
2	1963	105 000	22 000				X			X				X		
3	1963	95 000	23 000				X									
8	1964	90 000	25 000	X			X								X	
6	1964	95 000	27 000					X	X	X	X		X	X		X
9	1965	95 000	23 000				X	X								
7	1965	125 000	25 000		X				X							
11	1966	95 000	23 000				X	X	X	X			X	X		X
12	1966	120 000	28 000				X	X	X	X	X		X	X		X
14	1966	115 000	24 000		X		X		X	X			X	X		X
15	1966	120 000	18 000	X	X		X			X	X		X	X		X
13	1966	120 000	28 000				X	X	X	X	X		X	X		X
17	1966	95 000	22 000					X	X	X	X		X	X		
18	1967	95 000	22 000					X								
19	1967	120 000	24 000		X		X		X	X						
20	1967	95 000	24 000				X			X	X		X			X
21	1967	120 000	18 000	X	X	X		X	X	X			X	X		X
22	1967	120 000	18 000	X	X	X	X		X							
23	1967	95 000	24 000				X		X	X	X		X	X		X
24	1968	210 000	28 000		X	X	X									
26	1968	210 000	28 000		X	X	X									
25	1968	210 000	28 000		X	X	X									
27	1968	100 000	26 000		X		X									
30	1968	95 000	20 000	X			X			X		X	X	X		X
32	1968	195 000	28 000		X	X	X									
28	1968	95 000	20 000	X			X	X								
31	1968	115 000	28 000	X	X	X			X	X				X		X
34	1968	210 000	28 000		X	X	X									X
35	1968	100 000	23 000	X			X	X	X	X	X					X
37	1968	210 000	28 000		X	X	X									
33	1969	95 000	22 000				X							X		X
38	1969	215 000	28 000			X	X									
47	1969	195 000	28 000		X	X	X									
39	1969	210 000	28 000		X	X							Explosion			
36	1969	210 000	30 000			X	X									
40	1969	95 000	20 000	X			X			X				X		X
44	1969	205 000	28 000		X	X	X									
49	1969	210 000	32 000			X	X							X		X
42	1969	180 000	33 000		X	X	X									
46	1969	205 000	28 000		X	X							Explosion			
45	1969	205 000	28 000													
48	1969	100 000	23 000	X			X									
43	1969	115 000	25 000	X	X	X								X		

NUMBER OF SHIPS INVESTIGATED IN THIS GROUP, 69

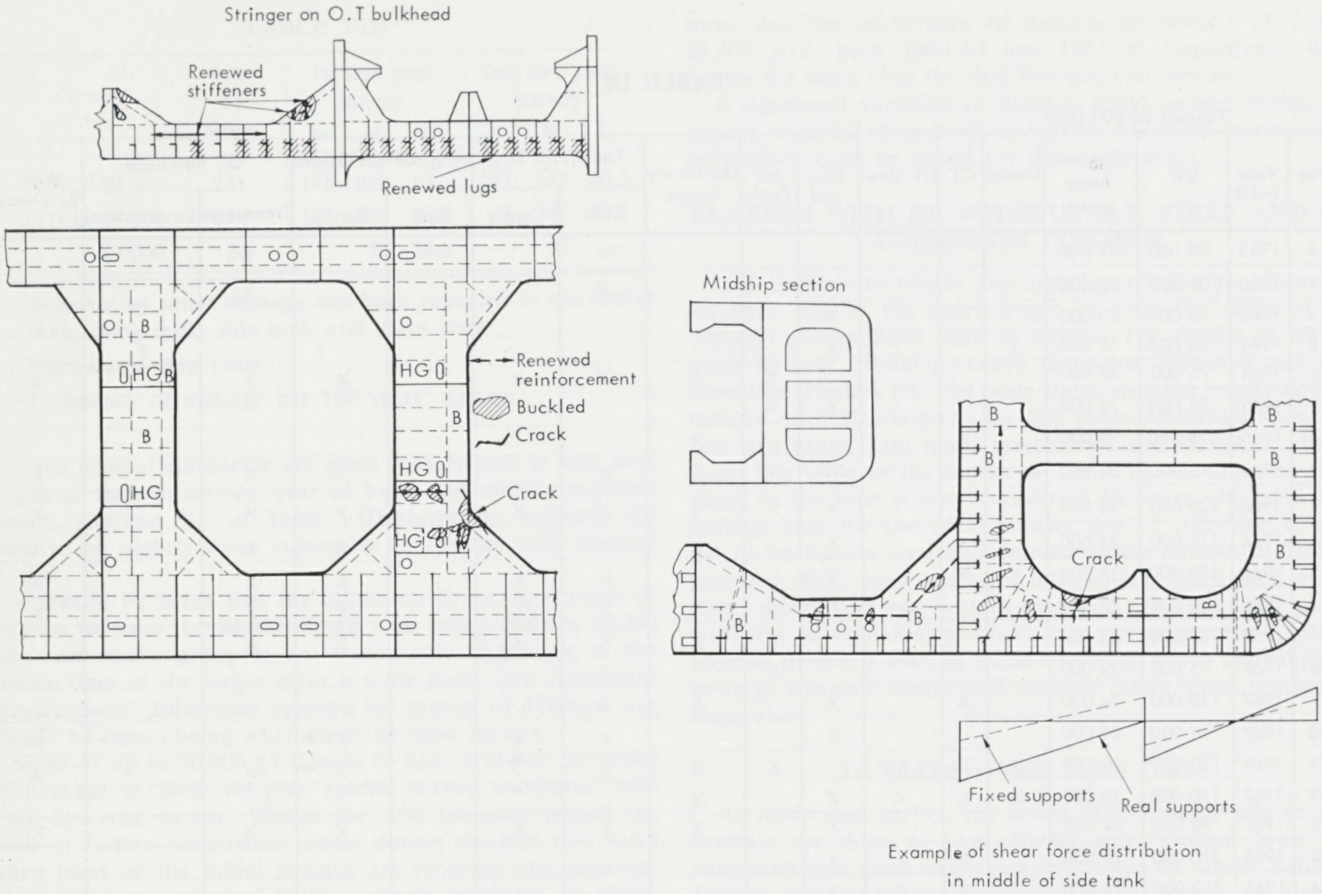


FIG. 26

CARGO TANKS

A few of the bigger failures were outlined in the introduction and Fig. 7 should be compared with Fig. 26 which illustrates the failures found in the main members, transverses, longitudinal girders and bulkhead webs of 100,000 tons dwt. ships after tank testing and some time in service.

All the damage indicated was not on one particular ship and although of no great significance the cost of repairing was high.

A type of construction shown in Fig. 27, which is suitable for evaluation by present-day finite element analysis suffered from many failures when it was first approved for construction prior to 1965. Table IX shows that damage occurred on about 15 out of a total of sixty-nine 100,000 tons dwt. ships which were built during the 1965–68 period, although it may well be that more ships were affected, as it is possible that all the failures that occurred during tank testing were not recorded.

The reports rarely indicate damage to bulkhead plating or stiffeners and in particular there was no indication of any damage on the longitudinal bulkheads, although close attention must be paid to the bracket connection between the oiltight transverse bulkhead horizontal stringer and the corresponding stiffening on the longitudinal bulkhead. However, in No. 1 tank a few ships have reported cracking and buckling of the brackets together with fractures in the bulkhead plating and Fig. 28(a) shows a detail which might also cause trouble, whilst Fig. 28(b) indicates a position from which there have been reports of fractures and double brackets or, if the production methods allow, a larger bracket may be required.

Tripping brackets should have a rounded easy connection with the longitudinals, otherwise a fracture starting at the toe can continue through to the shell plating as shown on Fig. 28(c). This happened on one ship which had a tendency to vibrate and, as the primary support for the longitudinal was very stiff, failure occurred. In general the performance in service of brackets has been good with the exception of those in No. 1 tank and on the wash bulkheads in the older type of tankers, where reinforcement has now been fitted, together with a few cases of failure in the bunker tanks at the forward end of the engine room.

The junction between the vertical web and the bottom longitudinal girder has been referred to elsewhere and a few cases have arisen where the transition between the face bar of the longitudinal and the vertical web has been too abrupt. An illustration of this is one particular case where a 920 x 34 mm. and a 305 x 22 mm. face flat were joined. There is no difference in the performance of the round (Japanese) and the straight (European) types of bracket, although there has been some cases of cracking of the face flat bar connection at the sniped ends where large stress concentrations can occur.

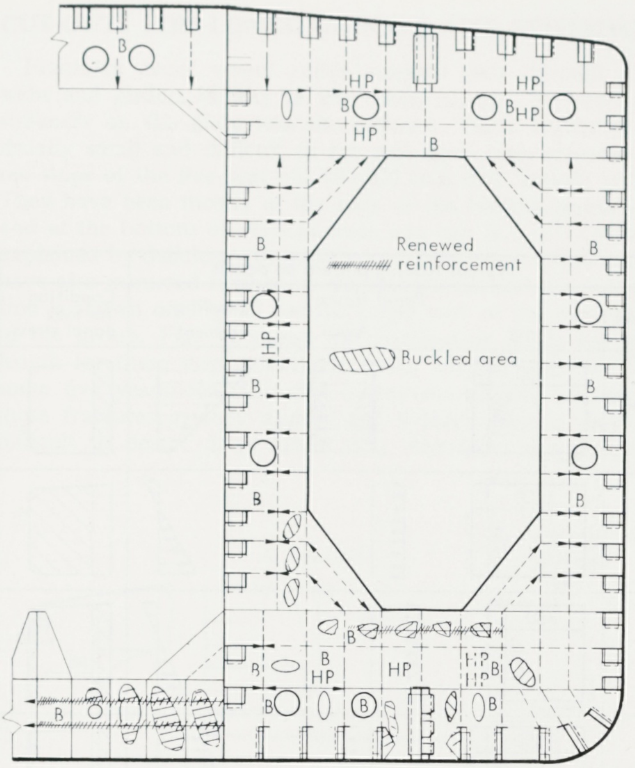


FIG. 27

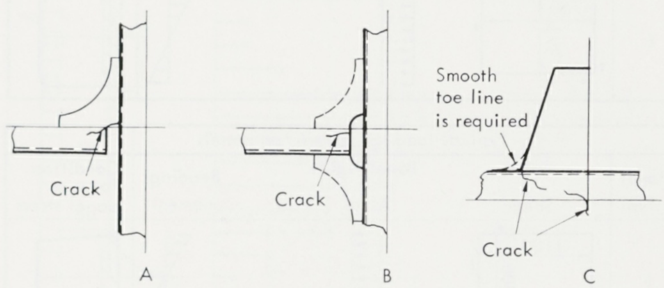


FIG. 28

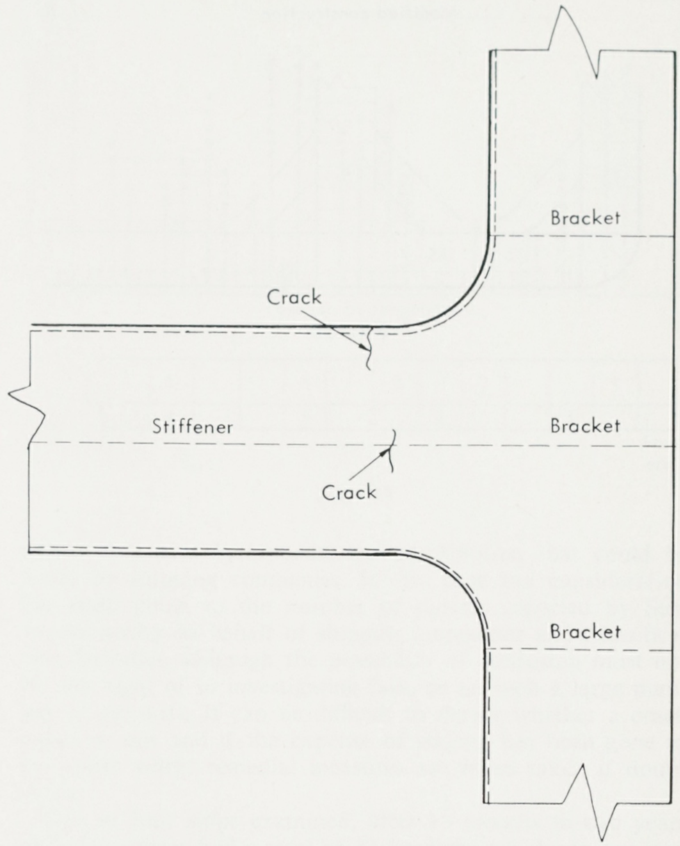


FIG. 29

Bottom and side longitudinals were expected to have a tendency for failure to occur at the stiffer support points such as bulkheads, etc., in comparison with the weaker supports such as transverses, but none could be found even though the situation is analogous to that of the centre girder. Difference in the practical performance between the "L" and the "T" profiles has not been noticed despite the former's lower range of effectiveness.

With the exception of where there was also stern damage there is very little evidence of damage in the cargo tanks caused by vibration and it cannot therefore be regarded as a practical problem. However, on the 26 per cent of ships that are not turbine driven, even though they are of the normal type of construction, vibration occurred in the wing tank cross-ties, although they had a well-rounded continuous transition and, on three ships, fractures occurred in this position quite soon after the ship entered service, starting in one case at the beginning of the rounding as shown in Fig. 29.

There are vibration problems on another 200,000 tons dwt. diesel-driven tanker of 25,000 b.h.p. where the stiffness of the primary members has had to be improved by fitting vertical stiffening to the face flats of the webs with extra tripping brackets. These tripping brackets, because they are sometimes attached to relatively weak longitudinals, offer only limited support, but even so they must be properly designed against fatigue cracking at the toe.

Plans of a ship are drawn two dimensional and it is easy to forget that movement will take place normal to the plane of the drawing and that details on the drawing have to be worked out with this fact in mind

During design and also plan approval it is now necessary in some instances to have a structural model to ensure that the total structure is given due consideration. Technical Memorandum No. 2(4) sets out a summary of the calculation procedure which has been established and gives loading cases to be considered, requirements of the structural model, allowable stress levels and panel size limitations to prevent buckling. It is, however, sometimes difficult to persuade shipyards to change their methods of construction even after they have been given proof of the success of the new design and Fig. 30 shows how a 100,000 tons dwt. ship was actually built against a schematic representation of the modification that was proposed.

That sufficient attention was not paid to the problems of buckling prior to 1965 is to some extent understandable. Study of Fig. 31, which was drawn up by a colleague in London Office for his own reference, shows examples of loading cases and associated stress combinations which are investigated as a matter of routine today.

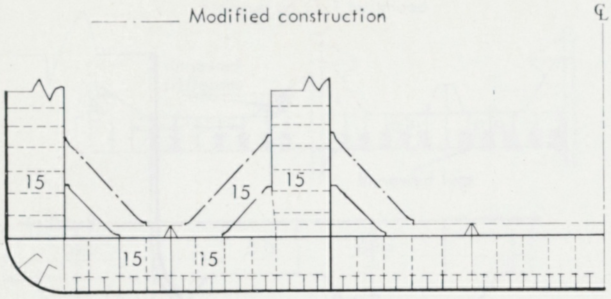
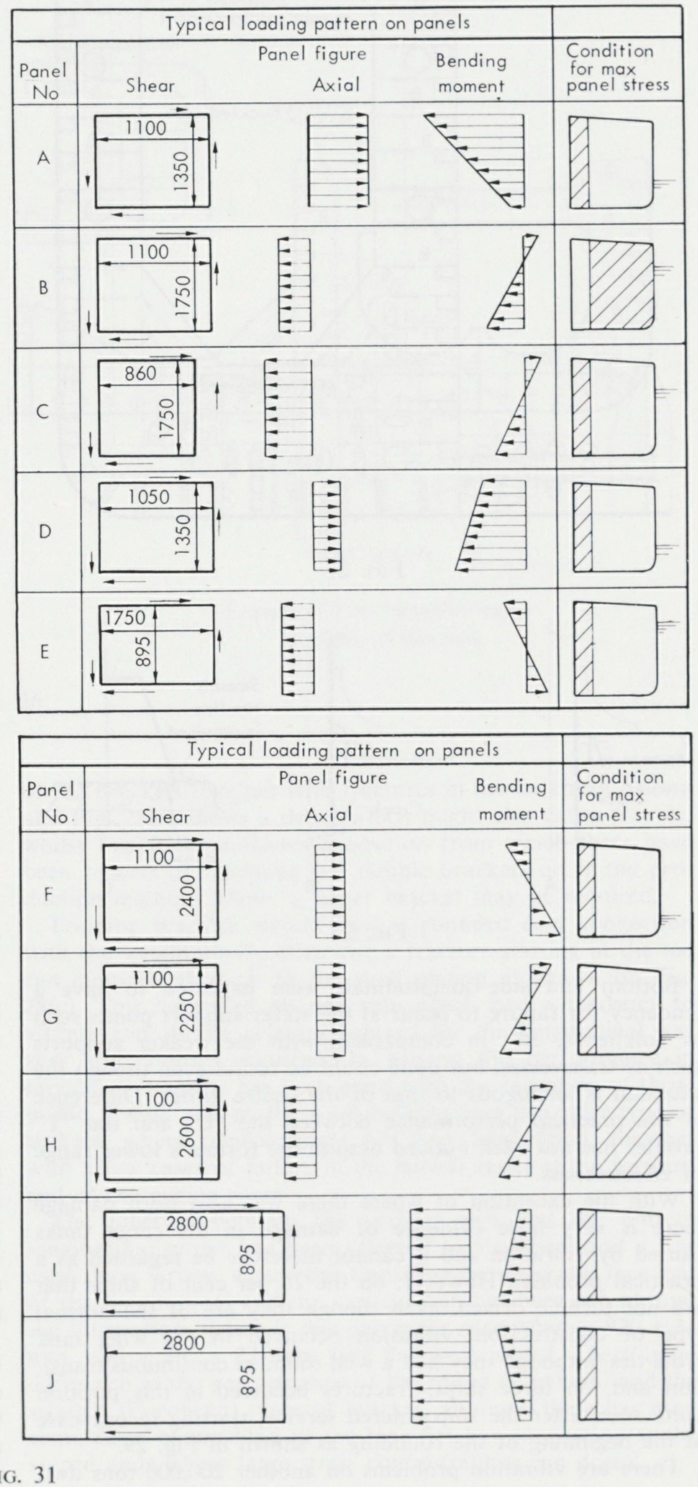

Modified construction
℄
15
15
15
15
15

FIG. 30


Typical loading pattern on panels
Panel No
Panel figure
Shear
Axial
Bending moment
Condition for max panel stress
A
1100
1350
B
1100
1750
C
860
1750
D
1050
1350
E
1750
895
Typical loading pattern on panels
Panel No
Panel figure
Shear
Axial
Bending moment
Condition for max panel stress
F
1100
2400
G
1100
2250
H
1100
2600
I
2800
895
J
2800
895

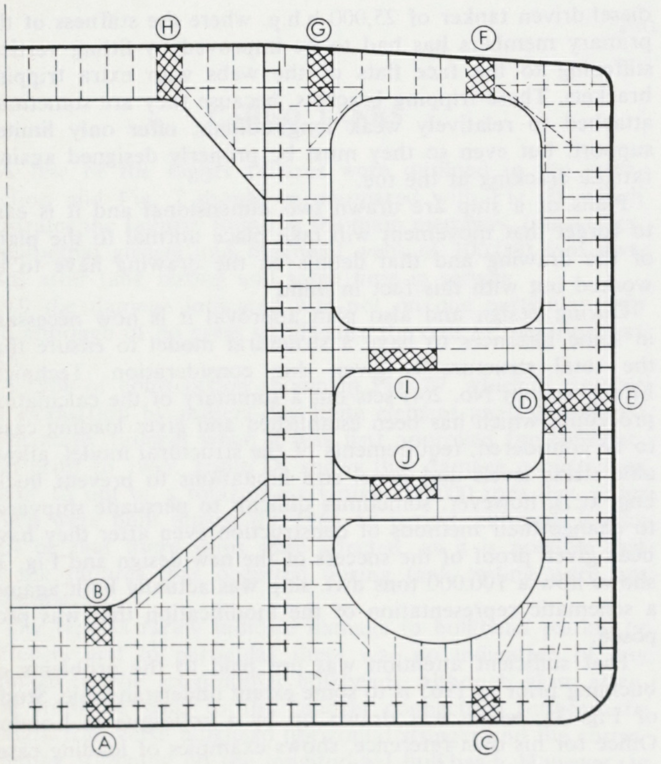

H
G
F
I
D
E
J
B
A
C

FIG. 31

CUT-OUTS FOR LONGITUDINALS AND STIFFENERS

Fractures occur where rolled sections pass through plate webs and girders in way of the notch cut-out, or where the stiffeners on the plate join the sections. These fractures are usually small and difficult to see and have been observed in ten ships of the five-year-old 100,000 tons dwt. sample group. They have been mostly at the ends of the bottom transverses and at the bottom of vertical webs and can in a few cases be explained by deficiency in shear area of the plate. Small cracks have also occurred further up the transverses and the distribution is shown on Fig. 32 for the cargo tank of the three ships in the group. Fig. 33 shows the distribution along the tank length for these ships which are about 100,000 tons dwt. and some five years old. Shipping companies usually just repair these fractures as they appear and without staging they are difficult to detect. Such tables may therefore be incomplete unless they also incorporate the contribution that could be made by shipping companies. In this case full consideration has been given to the number of defects reported by Surveyors acting on behalf of shipping companies and Classification Societies, although the possibility of confusion must not be lost sight of in investigating failures on such a large number of cut-outs. It can be difficult to decide whether a crack exists or not and if the expense of staging has been gone to for other work, remedial measures are often taken if doubt exists.

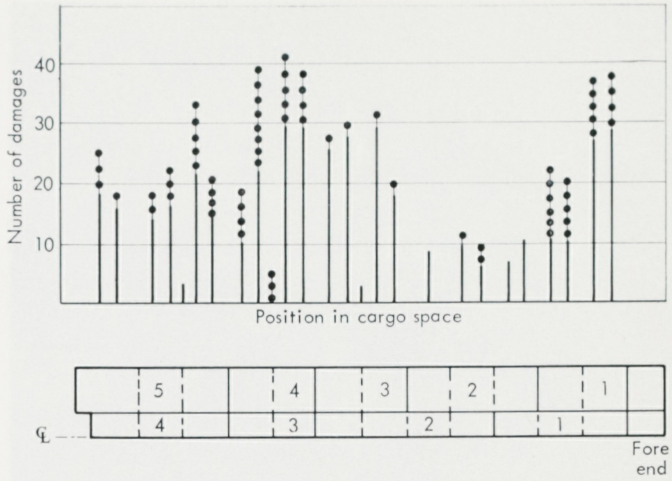
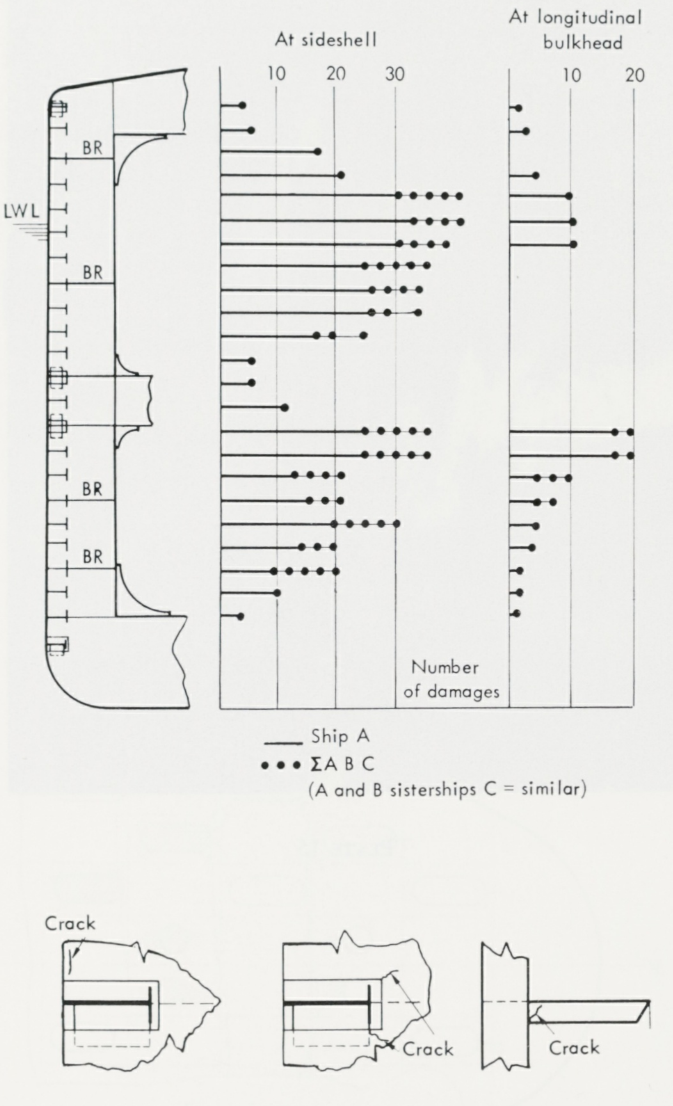


Fig. 33



Types of cracks

Fig. 32

Out of four ships examined, after 18 months to two years in service, three had a total of 13 fractures which ran out into the shell plating, with two low down in the ship and 11 higher up. Plates 13 and 14 show examples of this kind of fracture which occurred on a slightly smaller ship. One major feature of ships that suffer from this sort of failure is that they have a single cross-tie in the wing tanks. Later ships have the tripping brackets spaced closer together and whether or not double-lugged connections from the web to the longitudinal should be required is now under consideration.

This is, of course, the usual repair, together with a bracket on the web plate stiffener immediately above the longitudinal. Lapping the web stiffener and the longitudinal has, as a matter of fact, been much better in service as has been found from experience in the double bottoms of dry cargo ships.

Buckling of the face bars occurred in earlier ships due to the large upward pressure on the bottom shell when sailing with empty tanks as shown on Plate 15. It is possible that some of these failures were caused by extreme cradle pressure during launching. A study of longitudinal cut-out can be found in Refs. 5 and 6.

THE BOW

Even large ships are small in relation to the sea and Plate 16 indicates this and the picture is even more significant when it is realised that the sea state is only moderate. In the Introduction some rather large bow fractures were mentioned (*see* Fig. 8) and there are a few cases of such fractures in earlier ships. The widely spaced stringers were unable to support the vertical webs carrying the side longitudinals, when the stringer end brackets buckled and later the webs. In the worst case this leads to the cracking of the shell plating and the bulkhead at the end connection of the stringers and the damage was

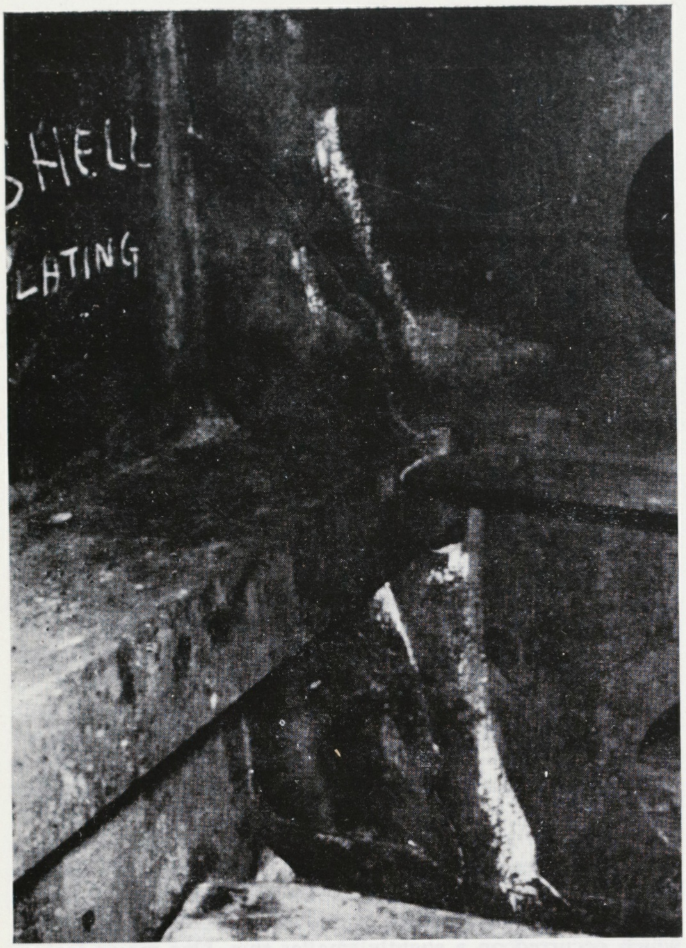


PLATE 13

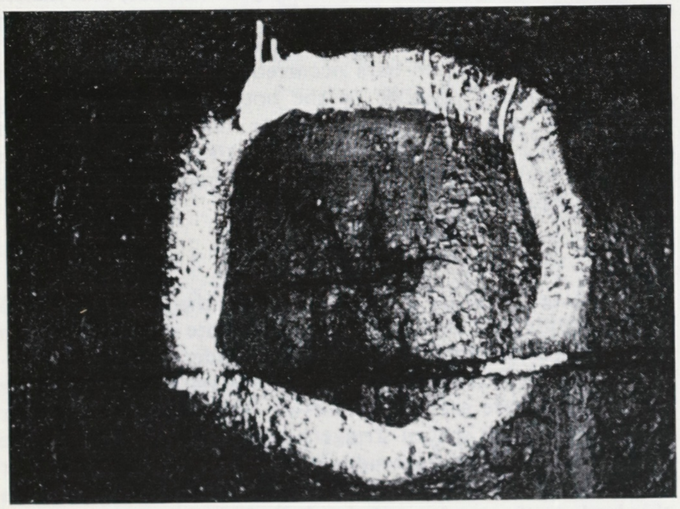


PLATE 14

PLATE 15

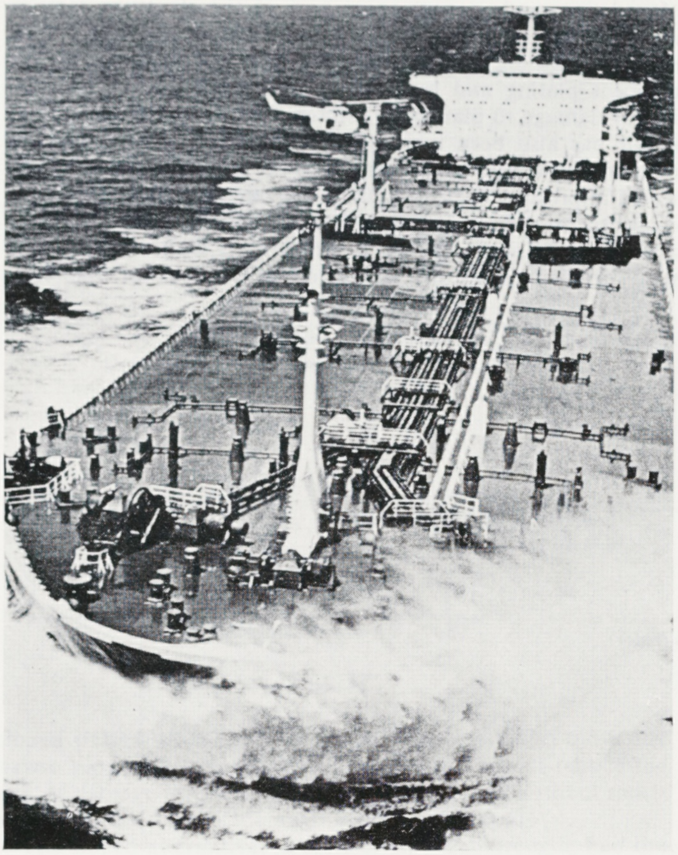


PLATE 16

repaired by increasing the stiffening. Another sort of failure is indicated on Fig. 34 where the girder under the wash deck buckled, as the position of the lightening holes and the deck beams slots made the plating ineffective as part of the beam when it was in compression. The above damage cases all relate to ships built between 1963–66.

The most common failures are the setting in of shell plating at the upper bow and on the forecastle deck, affecting one or two side webs between upper and forecastle decks and approximately three or four longtiudinals together with surrounding deck plating and as damage was not extensive, it did not require immediate repair. The usual type of repair has been to reinforce the longitudinals by future additional stiffening to the existing knee and in some cases intermediate vertical webs as shown in Fig. 35 where the angle between the shell plating, longitudinals and the webs is acute (*see* Ref. 7). The longitudinals transmit their loads into the webs where it will form a component acting normally to the web thus creating a tripping moment and the effective strength of the longitudinals is reduced under the combined action of lateral and compressive loads. Bow damage is the subject of an investigation being carried out by London Office at the moment with the intention of revising the Rules. Although bow damage is usually of minor importance it should not be neglected although on practical and economic grounds no drastic increase in strength would be justified to meet the largest predicted forces.

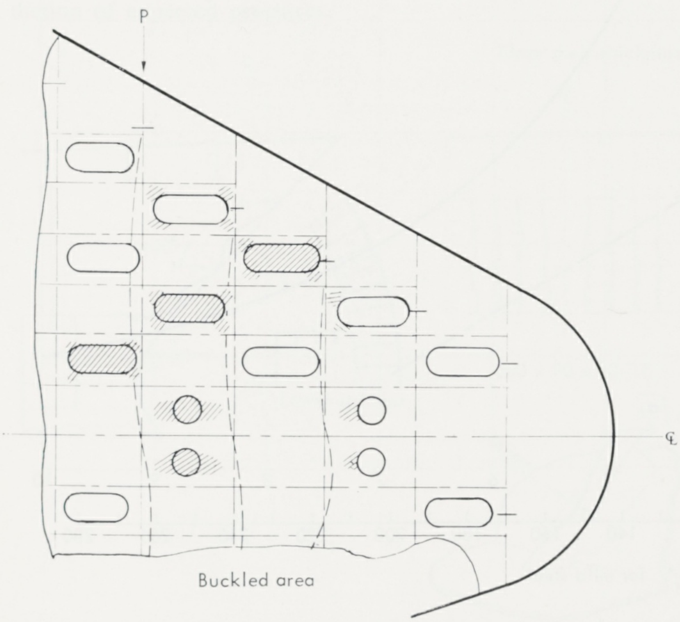


FIG. 34

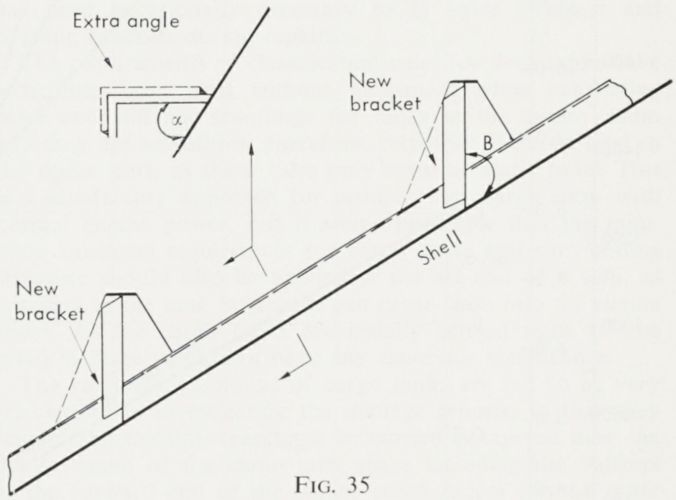


FIG. 35

In order to assess the magnitude of the forces acting on different parts of the bow a colleague in Gothenburg made simplified calculations, estimating the loads on longitudinals, webs and plates using the following equations:—

$$h = 560 \times \frac{w}{sL^2} \text{ or } 3000 \times \frac{A}{sL} \text{ for the web and longitudinals}$$

$$h = \frac{t^2}{s \times 0{\cdot}0032} \text{ for the plating.}$$

h = pressure height of water (M)
w = section modulus ($cm.^3$)
s = spacing (mm.)
L = span (M)
t = thickness (mm.)
A = cross-sectional area ($cm.^2$)

Computer programmes are now available to calculate the collapse loads more accurately (Ref. 8).

The diagram used for estimating the collapse load of pillars (Fig. 36) is from a paper prepared at London Office (Ref. 9). The yield point was placed at 2500 kp./mm.², the shape factor 1·4 for webs and profiles and the load factor 1. The bow has been subdivided and some of the results are presented on Fig. 37.

Reports of setting in damage to Suez Canal searchlight bow doors are often found, but they have been excluded from the survey. However, indirectly they do affect the statistics as after being made a permanent part of the structure damage in this area is included. This modification has often been effected only by permanently welding up the door to the adjacent plating and by fitting a very light centre-line web. Minor damage to plating and stiffeners which has not required repair has also been included in Table IX and therefore the column which shows the damage to the fore end gives a much worse impression than is actually the case. An interesting case occurred on ship B in Fig. 37 which is a 210,000 tons dwt. recently built ship—one of a group built with two different stem profiles as shown. Some owners opted for the very

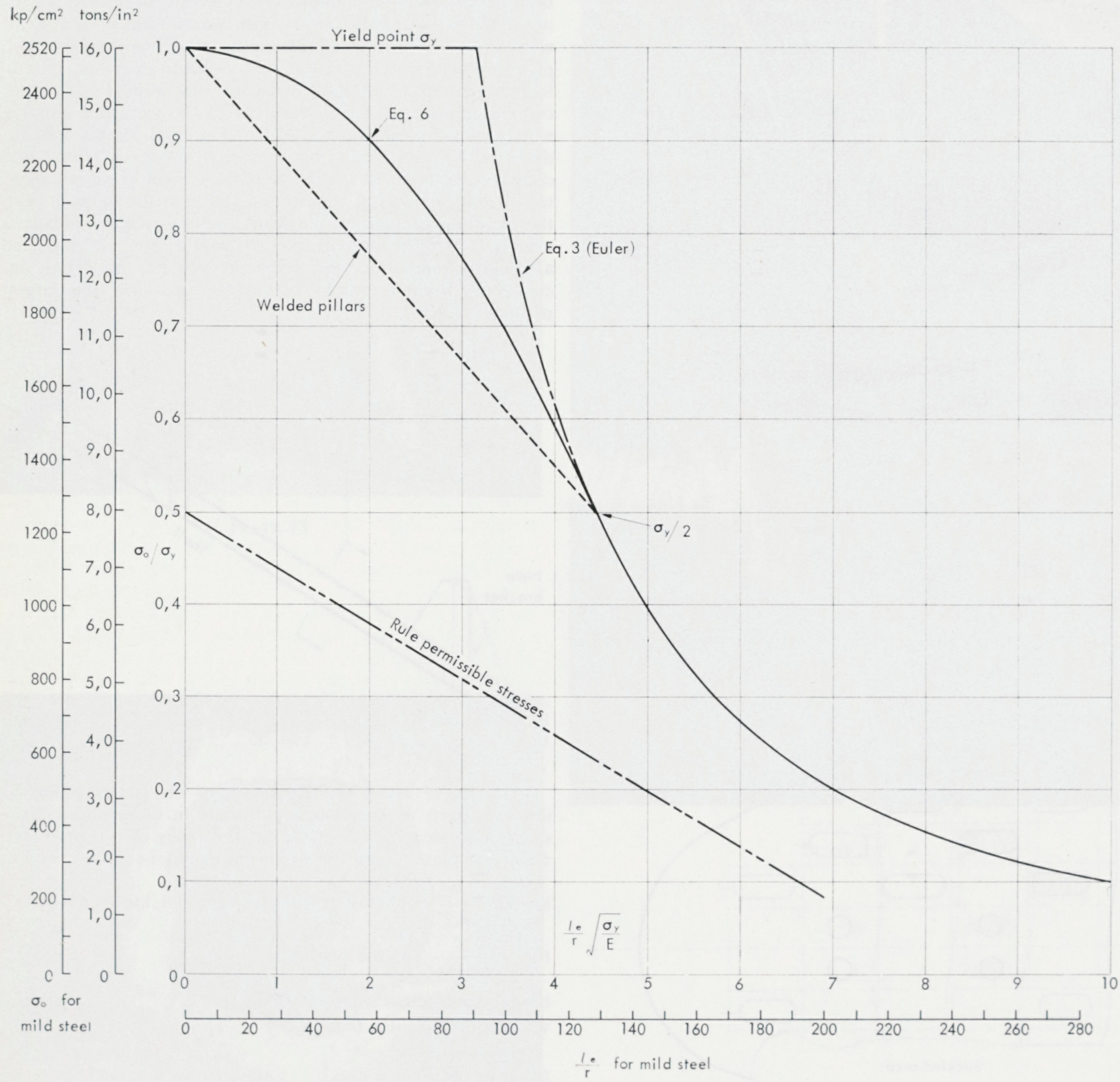


FIG. 36

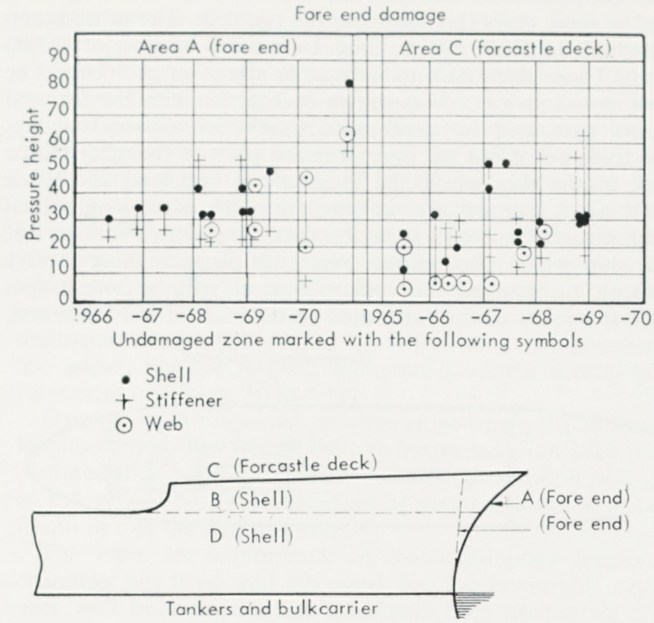


FIG. 37

sloped stem with a large flair making it possible to move the hawse pipe outboard and this it was hoped would reduce the risk of damage to the bulb from the anchor, but without much success as the rate of damage actually increased!

The sloped alternative, in spite of its great strength, had the frames buckled and the plating set in as shown on Fig. 37(b) and the bow was subsequently reinforced without much success and it is now understood from information received that the profile has been modified. Stems of the type A have given good service as far as is known. Extensive pressure measurements over the bow are now being carried out as part of an investigation to establish a realistic basis for the prediction of expected pressures.

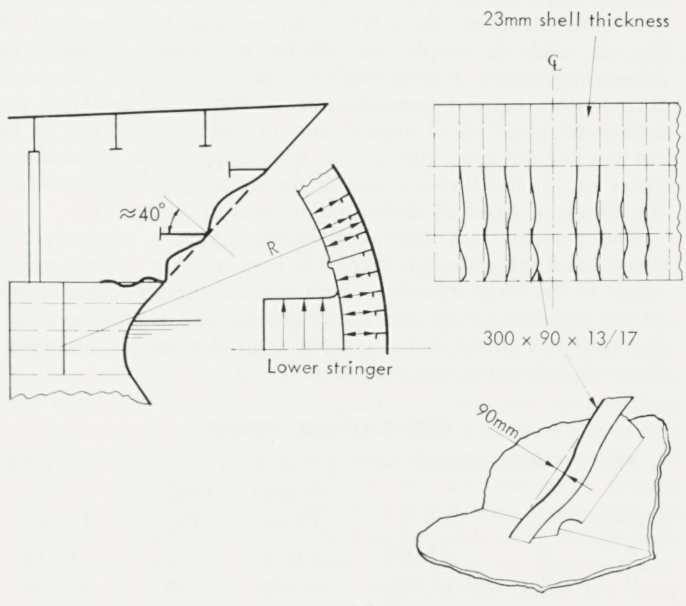


FIG. 37(b)

A small, often neglected detail, is the connection of the hawse pipe to the shell plating where repairs have had to be made many times. Thickened shell plating is not sufficient alone and stiffeners should be fitted between the longitudinals and brackets arranged from the pipe to the surrounding structure as an anchor for a 200,000 tons dwt. tanker can weigh anything from 20 to 25 tons. Cracks in the web are also reported at the notch cut-outs for the side longitudinals in this part of the ship. These cracks are more concentrated at the lower part of the web and because of this double lugs should be fitted for at least the bottom half depth.

AFT END

The damage normally found in this region is similar to that previously outlined for bulk carriers, with the area around the aft peak bulkhead being particularly prone to fractures and three ships have reported cracks in the shell plating, immediately aft of the bulkhead, level with the stern tube. Due to lack of consideration of detail, plate diaphragms and floors are poorly stiffened and the connection of stringers and stiffeners inadequate. Detail design is even more important in this part of the ship with its vulnerability to vibration damage.

Fractures sometimes occur in the engine room, to the welding and adjacent plating of the connections to the tank bulkheads, and in way of longitudinal cut-outs, mainly in the bottom half of vertical webs. Sections of Holland profile have been used as bulkhead stiffeners on some earlier ships and it has been occasionally necessary to fit extra stringers and tripping brackets during repairs.

The requirements of classification rules for deep tanks have sometimes been used without judgement when calculating plate and stiffener scantlings for tanks in the engine room and they are sometimes, therefore, relatively weak, at least in the upper part, as these rules only consider static head. This is a satisfactory approach for ordinary dry cargo ships with normal engine power, but it seems justifiable that the minimum thickness requirement for cargo tanks and surrounding structure should also be applied at the aft end of a ship, as cracking in the tank bulkheads can cause leaks into the engine room. As the cargo tanks are usually carried right aft the small increase would not have any economic significance.

The rules for scantlings of cargo tanks are felt to be very relevant after investigating the damage reports, in that they require the midship scantlings be carried untapered over the whole length of the cargo tank space including the bunkers at the forward end of the engine room except for the outer skin.

A colleague at London Office who looked into damage which occurred in the aft peak of some ships of 100,000 tons dwt. formed the opinion that there was sufficient horizontal stiffening, such as stringers, platforms and deep transverse beams, but that there was only the centre-line bulkhead running longitudinally. In view of the relatively large length and breadth of this space, it is considered that additional vertical support should be fitted and the additional structure is being incorporated on some of the large new ships.

Table IX shows that when the ship size increases from 100,000 to 200,000 tons dwt., there is a complete absence of damage reports in this area and it is obvious that much has been learned from the failures on the 100,000 tons dwt. ships and the detail design and standards of construction have been improved considerably with consequential benefit. This improvement did not occur overnight and improvement of detail

design requires an increasing awareness of all concerned, right down to the workshop floor, before becoming a reality. One reason contributing to the improved picture was that the increase in engine power was only from about 22,000 s.h.p. to 28,000 s.h.p. although the influence of the larger propeller clearance and improved flow have not been investigated. The experience only dates from early 1968, although this is a long time with problems of vibration.

LONGITUDINAL STRENGTH

So far there has been no indicating of inadequate longitudinal strength and this is hardly surprising as it is a most important factor in overall hull safety. The requirements have, therefore, always been conservative. Furthermore, the decks on the larger ships are usually in compression and the bottoms have only a few openings or discontinuities which could cause stress concentrations. Springing and whipping stresses must, however, be considered. It is therefore of interest to mention that a major oil company's confidence in the longitudinal strength was confirmed by an incident in 1966 to one of their 120,000 tons dwt. tankers which was the subject of extensive correspondence. From it it transpired that the ship was heading across the Irish Sea at half speed in very short waves at a draught about halfway between ballast and full load when it was subjected to a shock load causing it to shake violently as though it had run into a brick wall for about two to three mintes and the deck plating visibly waved. Several members of the crew fell over and a very concerned shipping company ordered immediate investigation, but on dry-docking no resulting damage could be found.

RO/RO SHIPS & CONTAINER VESSELS

The numbers of these large new types of ship are small and service experience limited; however, study has been made of the reports of some ten 180 to 200 m. Ro/Ro ships and 24 container ships either recently built or completely converted for that purpose.

The structure of these ships is more complicated than tankers and bulk carriers with many openings, gusset plates, corners, etc., all of which have a cracking potential.

Due to these complications this investigation was made with the preconceived idea that the nominal rule stress levels should be more conservative than those for dry cargo ships, particularly the hull girder modulus and permitted reduction for H.T. steel. However, the results of this investigation show this to be unnecessary, perhaps because the rules for dry cargo ships of necessity have been and are flexibly framed and applied, precaution thereby already having been taken.

The design of these ships is also carefully considered in detail and any desirable changes can be made as there are relatively few standardized constructional details for these ships.

Failures have not, however, been eliminated altogether, but the overall picture is good with the exception of their susceptibity to vibration.

RO/RO SHIPS

Two groups of ships have been studied under this heading, one group built in 1967 are 20,000 b.h.p. diesel driven, single screw, 180 m. long. There was only some minor cracks on internal members and bulkheads caused by aft end vibration. The propeller was changed and number of blades increased and in most cases this did solve the problem. The other group was built in 1969, 200 m. long, twin screw turbine of 35,000 s.h.p. These ships had no noticeable vibration problems. The deck was constructed, as shown in Fig. 38, with the forward centre part used for containers. Cracks have been found at the transition from the open forward part, to the after closed part of the ship where the longitudinal bulkhead and hatch shelf plate forward are scarphed into the after longitudinal deck girder. On board were the detailed plans of this part of the ship which was spread over two plans, making it very difficult to examine the construction at such a critical spot with the joints of the fabricated sections aft of the hatch end.

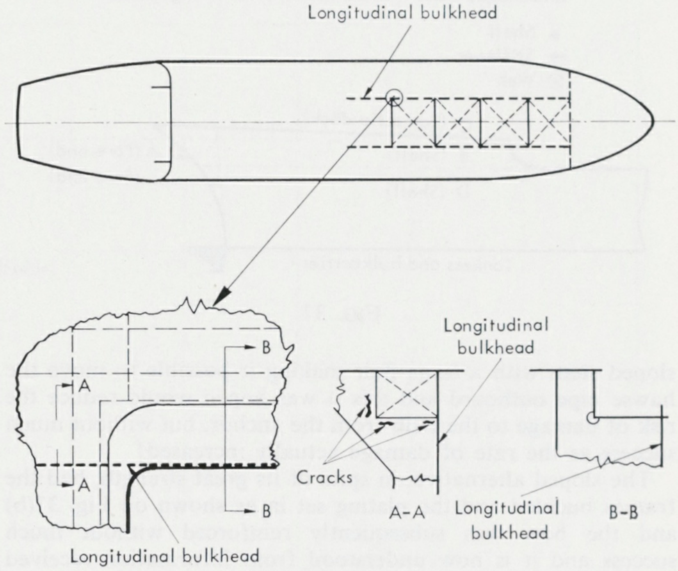


FIG. 38

A detail that should be considered on container ships is the connection of the longitudinal struts used to attach moveable car decks or vertical container guides. They must be given careful attention as they will be subject to tension where they join other struts or decks. This can be caused by the load on the car deck or simply the relative movement between the supporting points. Easing brackets and other details do therefore require careful consideration as the space available for additional brackets is limited and in some cases have to be cut out for the container guides. Similar problems arose many years ago at the forward end of the midship deckhouse when the fitting of fixed or sliding pillars was in contention.

The present deck plating thickness appears adequate for wheel loadings, although there was concern that failures might occur at the large transverse web vertical support connections as the ship has hardly any transverse bulkheads and the swaying sideways might have induced high stresses at this point. No such indication has been found.

CONTAINER SHIPS

The 24 ships studied were grouped as shown in the table.

Group	No.	G.R.T.	Engine Power	Engine Type	Length
A	9	25,000	30,000	T	210 m.
B	6	9–14,000	16,000	D	150 m.
C	9	3– 9,000	7,000	D	115 m.

In 11 of these ships hull damage has been reported. The smallest group, Group C, has had very few failures and would appear to have a behaviour pattern similar to that of a traditional dry cargo ship, possibly a little better. The same can be said of the intermediate group B, but a certain amount of damage has been reported at the aft end, mainly located in the region about the lower part of the aft peak bulkhead.

The large ships, Group A, of 25,000 g.r.t. have only single screw propulsion, but have an engine power that exceeds that of a 200,000 tons dwt. tanker and is consequently subject to vibration damage, in the peaks, engine room and deckhouses, which are usually situated as far aft as possible, the consequences of which the crews have had to learn to live with. A discussion of damage caused by vibration is not possible in this paper, but for interest, there are available several good references (*see* Refs. 10 and 11).

Damage is also reported on some ships where the additional longitudinal girders within the hatchways have not been made continuous and Ref. 12 gives a complete description of a ship of this group. No other instances of major damage have been found in this the largest group.

The case for continuous or non-continuous hatchways coamings has been well discussed and the favourable experience with bulk carriers has sometimes been used as an argument for them being discontinuous. However, the latest large container ships either building or contemplated seem, in general, to be fitted with continuous coamings. The damage mentioned in the case of a non-continuous coaming is illustrated partly in Fig. 39 where the shaded areas indicate where modifications have had to be made. The girders and coamings have not been included in the longitudinal strength of the ship

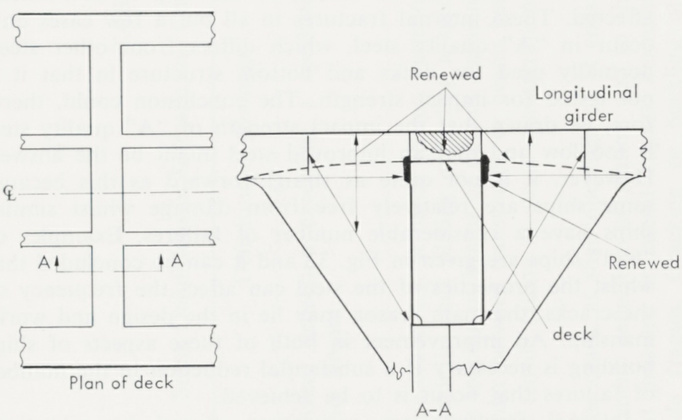


FIG. 39

as they were not continuous. Damage has mainly been reported at the longitudinal girders within the hatch as continuity for the axial forces at deck level to the girders within the hatchway must exist irrespective of how the longitudinal strength is calculated. It was also found that the butts of the longitudinal girder web were not full penetration welds. In ships of the intermediate Group "B" and the large Group "A", small fractures have occurred at the toes of brackets on the hatch side coamings as the bracket ends were not smooth enough and similar failures also occurred at the normal transverse bracket to the side coamings. As the decks are very narrow the base length of the brackets had been shortened in spite of the very large coaming height and now instead of sniping, the flange has been attached to the deck plating with a welded gusset plate.

On the large hatch covers horizontal fractures have been reported on the side plates (Fig. 40), just beneath the packing bar for ships of the intermediate Group "B" and the large Group "A". The fractures normally occur in way of the girders which carry the large point loads from the containers and a thicker insert plate is now normally required in the hatch cover side where contact between cover and coaming bar occurs.

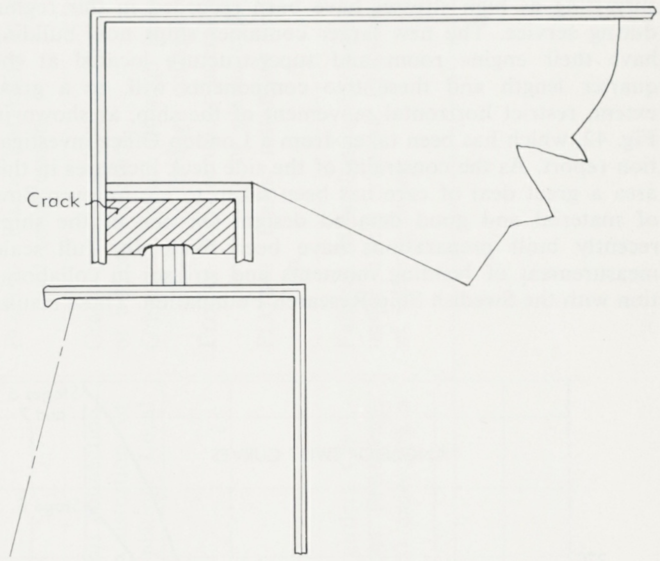


FIG. 40

In some fast dry cargo ships, not included in this investigation, buckling has been reported in the upper deck and shell plating in way of Nos. 1 and 2 hatches. The ships have lengths varying from 140 to 170 m. and have a maximum speed of about 20 knots and sustained the damage when operating in an oblique sea at high speed (not extreme bad weather). When the stem of a ship goes into the sea the hull is subject to a large vertical wave bending moment together with a horizontal wave bending and torsional moment. Study of Fig. 41,

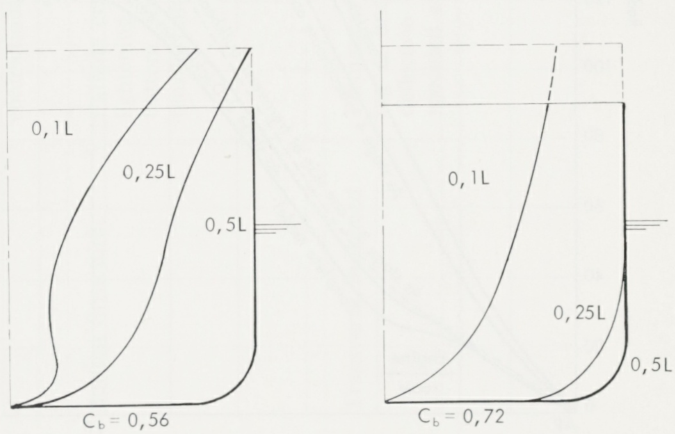


FIG. 41

which is from a London Office report, shows the change in lines and displacement along the ship with compressive stresses on the leeward side. However, there would appear to be no reports of damage of this type to container ships and no doubt a factor contributing to this could be that the midship longitudinal scantlings are carried untapered almost from forward to aft and several of them have longitudinal framing of the side shell.

The double hull feature which creates a larger horizontal modulus has a diminishing influence as it passes forward along the hull. There has not been any damage to the deck plating at hatch corners although this is perhaps somewhat surprising as high stresses have been recorded in this region during service. The new larger container ships now building have their engine room and superstructure located at the quarter length and these two components will, to a great extent, restrict horizontal movement of the ship, as shown in Fig. 42, which has been taken from a London Office investigation report. As the constraint of the side deck increases in this area a great deal of care has been taken to ensure even flow of material and good detailed design. On one of the ships recently built preparations have been made for full scale measurement of bending moments and stresses in collaboration with the Swedish Ship Research Foundation. These results will be of interest especially as the ship has discontinuous coamings and measurements will include stress flow in the coamings and the transmission into the deck plating at the ends of the hatches.

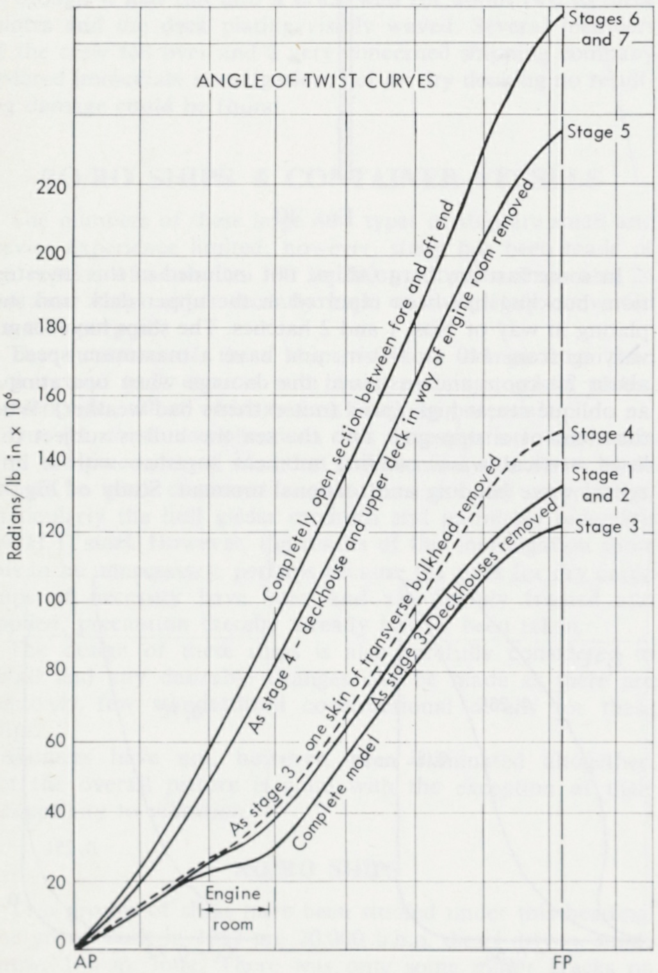


FIG. 42

MATERIALS AND METHODS OF PRODUCTION

In the first part of this paper there has been a general discourse on the failures that have occurred on ships from the point of view of design. There are two other important factors which effect the functional stability of the hull that originate during building, namely the choice of materials and the production methods that are used. These two factors will be briefly discussed and mention will be made of the importance of quality control together with cases of corrosion that have been found in the reports and failures caused by faulty detail design and bad workmanship.

Failure can be regarded as damage or collapse. The difference between the two may be explained by defining damage as minor changes in shape, which has no real immediate loss of function, whereas collapse means such a change as to impair the function altogether. Reference should be made to Table X (Ref. 13). None of the cases in the reports which have been reviewed can be called collapse.

The information that is contained in the damage reports can be divided into different categories and fractures in internal members can be compared with those that have occurred in the shell plating and the strength deck. Significantly, there are more fractures in the internal members, though how many more it is not possible to ascertain, due to the fact that there are large numbers of them and the relative unimportance of most of them means that reports are often superficial in their content. Fortunately, the safety of the ship is not usually affected. These internal fractures in all but a few cases only occur in "A" quality steel, which differs from other steels normally used for decks and bottom structure in that it is not tested for impact strength. The conclusion could, therefore, be drawn that the impact strength of "A" quality steel is too low and that an improved steel might be the answer. However, it is not quite as straightforward as this because some ships are relatively free from damage whilst similar ships have a considerable number of failures. Examples of "bad" ships are given in Fig. 32 and it can be concluded that whilst the properties of the steel can affect the frequency of the cracks, the main reason may lie in the design and workmanship. An improvement in both of these aspects of shipbuilding is necessary if a substantial reduction in the number of failures that occur is to be achieved.

Internal fractures are sometimes caused by vibration, especially in the region of the after body and aft peak. There have been a few reports of damage occurring in the cargo tank spaces as well.

The instances of damage that have been reviewed usually occurred at the toes of brackets, in way of a discontinuity of some kind, or vertical fractures in bulkheads or shell plating near the connection of stiffeners. This shows that it is important to avoid undercutting in these places. Vibration stresses from the machinery and the propeller are usually high cycle, low stress and, therefore, the effect of notches are significant (*see* Ref. 10). The way to improve a situation which may be subject to vibration is to try to reduce them at source, improving the detail design and local stiffening rather than put a lot of effort into increasing the fatigue strength and/or the ductility of the steel.

TABLE X

Some Definitions of Damage and Collapse for Various Structural Elements.

Structural Member	Definition of Damage	Definition of Collapse
Hull Girder	Permanent deflection exceeding a specified fraction of the ship length.	Extensive fracture due to brittle failure. Extensive plasticity and buckling at the ultimate bending moment.
Strength Deck	Fatigue crack, e.g. at hatch corner. Permanent deflection or buckle in deck plating exceeding a specified fraction of the spacing of beams or girders. Permanent deflection of girder between transverses, or beams between girders. Local tensile failure at stress concentrations.	Crack traversing deck. Overall plastic instability of deck panel, possibly including transverse beams. GIRDERS Plastic instability between transverses. BEAMS Plastic collapse under lateral loads. PLATING Plastic instability between girders.
Side Shell	Fatigue crack at shell openings or at ends of erections. Permanent deflection of plating due to shear buckling, lateral pressure or lateral impact. Permanent deflection of side frames. Cracking or buckling of beam-frame connections.	Overall plastic bending collapse of side panel (plating and frames) under lateral pressure, impact load, etc. FRAMES OR GIRDERS Fracture or plastic collapse under lateral load. PLATING Plastic instability in shear, or combined shear and compression.
Bottom Structure	Fatigue crack from discontinuity, structural connection, lightening hole, etc. Permanent overall distortion of bottom structure. Corrugation of shell plating. Local tensile failure at stress concentrations.	Crack traversing bottom shell. Overall plastic instability of bottom structure. GIRDERS Failure through instability in compression or shear, or through collapse under lateral load. FLOORS Failure under lateral load due to shear instability in web, or plastic collapse as beam. PLATING Plastic instability under longitudinal compression.
Transverse Bulkhead	Permanent deflection of stiffeners or cross-girders. Cracking or buckling of stiffener and connections. Permanent deflection of plating (relative to stiffeners) exceeding a specified amount.	Failure of stiffeners through plastic bending collapse under lateral pressure. Fracture of plating leading to loss of watertightness.

Lamellar tearing is an old problem, but on todays' big ships with increased loads, high residual stresses due to larger amount of weld material and thicker plating with relatively poorer tensile strength in the thickness direction, this problem has become even more accentuated. Some of the cracks found in the reports may, as stated previously, be referred to as lamellar tearing. It seems a difficult problem to solve, but in the first instance the detail design must be specially considered taking this problem into account. Another necessary precaution is to check the plating before welding if lamellar tearing is expected. Ultrasonic testing is commonly used, but small tensile test pieces, where the contraction is measured, may also be used. Steel made by the continuous casting process has rounded slag inclusions and ought to be better from this point of view. At least one Swedish steel manufacturer now offers what they call Z-steel with improved properties in the thickness direction, but even with this kind of steel no guarantee can be given by the manufacturer (Ref. 14).

Practical experience with the use of H.T. steel is limited, but the reduction in the number of fractures in the deck and bottom shell plating seems encouraging.

Ship's scantlings are determined using only the tensile strength of the material, its other properties such as notch toughness, ductility and brittleness, only being taken into account for initial approval of the steel. These properties do not necessarily follow the same pattern as the tensile strength and therefore, when changing to H.T. steel, fatigue failures and brittle fractures could become a greater or less risk than before. However, a number of fatigue tests made on H.T. steel have not shown up any difference in respect to that of mild steel. The higher nominal stress level which is allowed when using H.T. steel together with unavoidable local stress concentrations of such things as deck openings and fitting out items, plus any imperfections in the welding, are the main reasons why H.T. steel has been unfavourably compared with mild steel, when considering the possibility of fatigue cracks. The ship's beam is exposed to a lot of different types of loading. From the point of view of selection of material, attention must be particularly paid to problems that might arise in connection with brittle fracture and low cycle fatigue. When H.T. steel was introduced a lot of precautions were taken to minimise the possibility of cracks and the so-called "k" factor was used to prevent the full use of the higher yield strength of the material, and design detail was to be specially considered. Improved welding control and stricter requirements came into force to compensate for the greater risk of failure, that was assumed would happen, using H.T. steel.

Up to now there has been no indication of any increase in the frequency of failures due to the use of H.T. steel, in fact the statistics show a decreasing trend in failures reported to hull and deck plating on tankers and other cargo ships as well (Ref. 15). This trend is believed to be one of the reasons for the proposal to adjust the "k" factor. In future it will be based only on the yield point of the material with a minimum value of 0,725 and the value of "k" will be derived from the formula: —

$$k = \frac{25}{Y}$$

Y = yield point and subsequently the maximum yield point for a steel without restriction is 34,5 kp./mm.^{2}

The Society, as it is well known, has adopted the I.I.W. formula for the carbon equivalent for use with H.T. steel. The upper limit of the C.E. for rutile electrodes is 0,41 and for basic coated electrodes 0,45. Above these values preheating must taken place. This formula is only based on the analysis of the steel and no account is taken of the parent metal thickness, the ambient temperature, or the method of welding with regard to heat input. It is interesting to compare difficulties that have arisen during building with failures that have occurred later, and it cannot be denied that there is evidence that failures which occur in service immediately after delivery, may well arise from these.

Experience of shipyard welding all around the world seems to indicate that apart from lamellar tearing. there are two particular problems which arise out of welding, the first being the low impact strength of the heat affected zone when using electro-slag, consumable nozzle, or other modern high heat input welding methods. All the Classification Societies have some form of restriction to combat this and as far as is known there have not been any reports of damage due to low impact strength. A number of strakes of notch-tough material are considered necessary as a safety precaution, but recently a number of amendments have been suggested to the Society's Rules.

The other problem that arises during the welding of H.T. steel is what is thought to be hydrogen cracking, associated with large thicknesses of parent metal and extremely low heat input welding methods. An example of this (one reported from many shipyards) occurs at the overhead manual welding between the deck and the deck longitudinals in way of the cross joints between the prefabrication units. They usually appear as shown in Fig. 43 and are often difficult to detect.

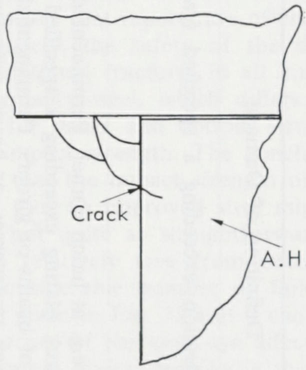


FIG. 43

The upper seam of the bilge strake, usually now of EH quality steel, is another place where hydrogen cracking has been reported (Fig. 44). These are also difficult to detect and a dye penetrant or a similar method has to be used. Other reasons for trouble are the presence of shop primer and poor edge preparation. It has been shown that the frequency of these failures arises during wet and cold weather.

This kind of failure can also appear in downward vertical welding and does not only affect H.T. steel. At least two runs, but preferably three runs, shall be laid, so arranged that the latter run normalises the previous ones but does not touch the parent metal. Another and better method is to use the upward technique for the final run.

A few other sources of failure are high speed welding of butts as well as fillets and the edge preparation has a definite influence on the final result. The use of shop primer is important.

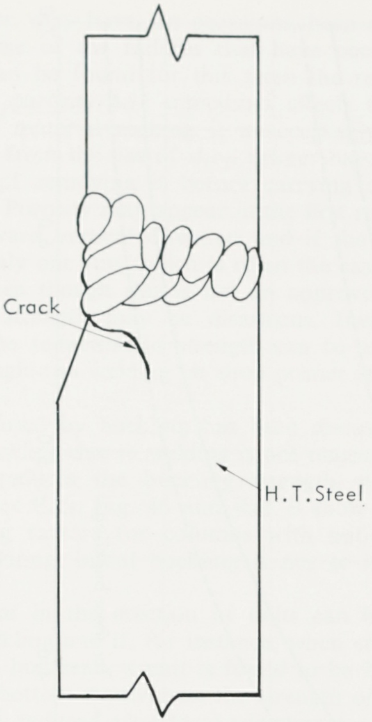


FIG. 44

Many shipyards have problems with butt welding plates in the prefabrication bays where one-sided or two-run welding technique is used. A butt weld of this type may be 15 m. or more long and the welding success is highly dependent on small gap tolerances. Usually the welding is started at the middle of the plate running towards both ends at the same time, but it may be made from one end to the other and hot cracks sometimes appear in the welding at the end of such runs. The explanation given for these hot cracks is that they are caused by an increase in the energy that has to be absorbed, because the heat produced cannot be dissipated quite so quickly towards the edge of the plate and high stresses are induced (*see* Fig. 45). Yet another reason may be the preparations made by the operator to stop the welding machine.

Shipbuilding is making increasing use of one type of electro-slag welding, namely the consumable nozzle, for welding butts in the bottom and deck longitudinals where there is a moderate depth and a sufficient thickness of plate to permit electro-slag welding. Problems can arise, especially in way of the deck plating when the weld is continued from the longitudinal into the plate and careful examination of these spots is very important in order to prevent damage of a more serious kind in the future.

Horizontal welding using high efficiency electrodes having powdered iron in the coating is very attractive to shipyards from the point of view of economics, but it does run the risk of both hydrogen and hot cracking particularly if rutile electrodes are used and the weather is bad. Sometimes a root gap and incomplete fusion is found, though not always as bad as shown by Plate 17.

PLATE 17

Edge preparation using oxy-acetylene flame cutting equipment is common practice and produces a very thin layer which has a very high carbon content. Provided the correct electrode is used, the slag completely removed and the surface of the plate edge completely melted, the risk of trouble later will be eliminated. If this does not happen problems may arise from the parts left with a high carbon content. The use of the carbon electrode/compressed air (the arc air) method to prepare the backrun also gives a surface with very high carbon content, but it is not thought to be harmful provided the normal requirement of having the edge buffed with an emery wheel before welding is carried out.

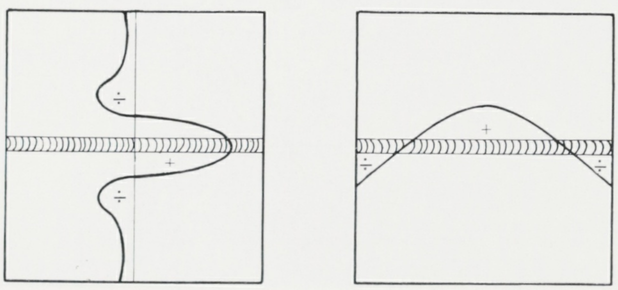


FIG. 45

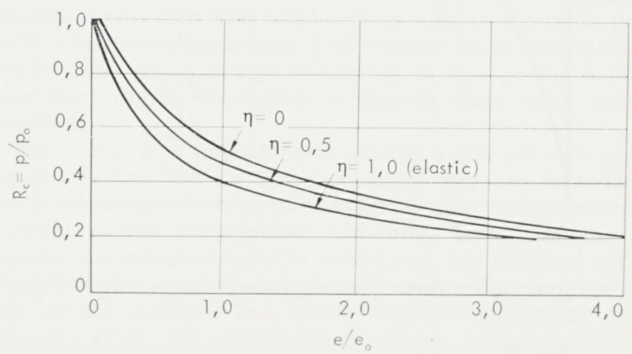
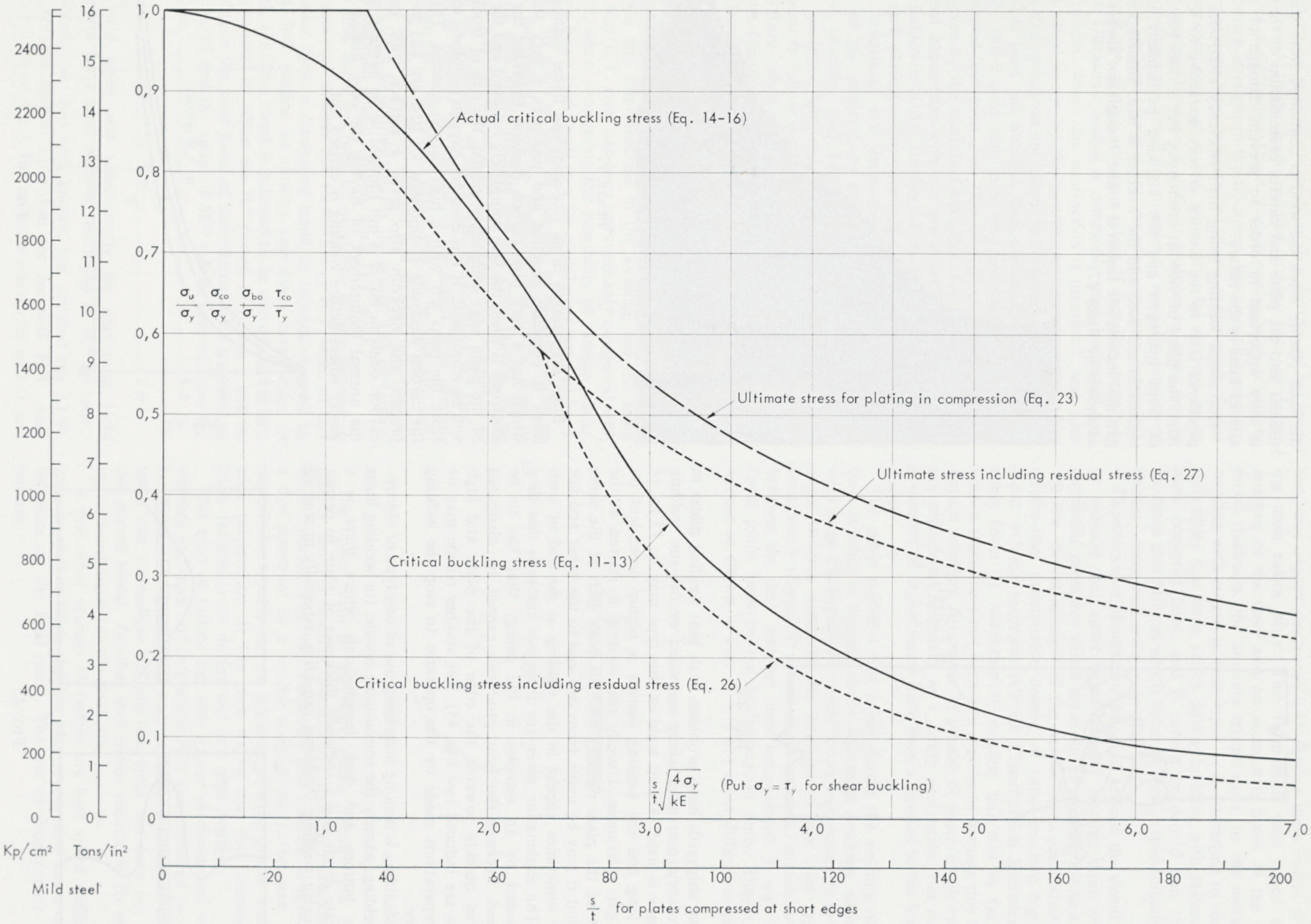


FIG. 46



Actual critical buckling stress (Eq. 14-16)
Ultimate stress for plating in compression (Eq. 23)
Ultimate stress including residual stress (Eq. 27)
Critical buckling stress (Eq. 11-13)
Critical buckling stress including residual stress (Eq. 26)
$\frac{\sigma_u}{\sigma_y}$ $\frac{\sigma_{co}}{\sigma_y}$ $\frac{\sigma_{bo}}{\sigma_y}$ $\frac{\tau_{co}}{\tau_y}$
$\frac{s}{t}\sqrt{\frac{4\sigma_y}{kE}}$ (Put $\sigma_y = \tau_y$ for shear buckling)
Kp/cm²
Tons/in²
Mild steel
$\frac{s}{t}$ for plates compressed at short edges

FIG. 47

Shop primer, may have, on occasions, been a contributory factor on some of the failures that have occurred, but no verification can be found for this from the reports. It may contribute to porosity and sometimes affects the quality of the deposited material making it unacceptably brittle. Problems arising from the use of shop primer have given rise to the practice of removing it before carrying out automatic fillet welding. Porosity may appear in the first run particularly in the downward vertical direction and if the weld is completed with only one run, which is often the case for a 4 mm. fillet weld, even though this is not an approved method the reduction in strength may be disastrous. Investigation has shown that the reduction in strength can be as much as 60 per cent if single-run welding on shop primer takes place (*see* Ref. 16).

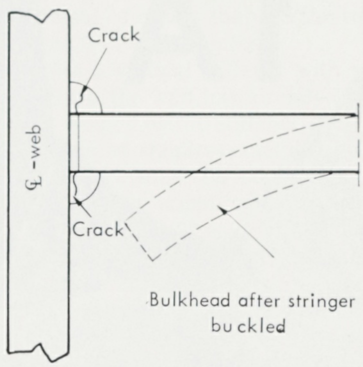
Damage caused by buckling has been discussed elsewhere and initial buckling due to welding is not unusual. This initial deformation reduces the buckling strength, particularly of pillars and face flats. Fig. 46 and Ref. 9 show the reduction in the loading factors for columns with initial deflections, though for plating, initial buckling is not so important (*see* Fig. 47).

Misalignment in the erection of units can have an effect similar to buckling and if, for instance, when erecting part of a longitudinal bulkhead, a unit is found to be 25 mm. out of line with the bottom transverses, the strength of the structure is considerably reduced after local adjustment.

Brittle fracture seldom occurs in service, though such fractures can occasionally be found after grounding. Plate 18 is an example of brittle fracture caused by the violent forces which occurred on grounding. That such steel should not be used can be argued but the shock loads that will cause a brittle fracture are so violent and so much above the normal service loading, that it is beyond the duty of a Classification Society to require sufficient strength to contain them.

QUALITY CONTROL

During the testing of a European built ship, which was not to class, a transverse bulkhead collapsed because the centre-line web buckled at a stringer connection with buckling and cracking of the stringer (Fig. 48). Investigation showed that the first thing that went wrong was that the fillet welded connection between the bulkhead plating and the web cracked due to bad fitting, causing the web to buckle and then the stringers. The report ends laconically "Of course, the importance of welding of the end connection of all primary members is well known".



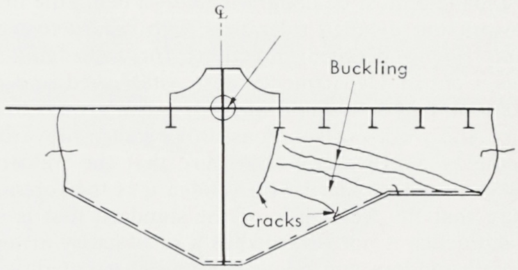


FIG. 48

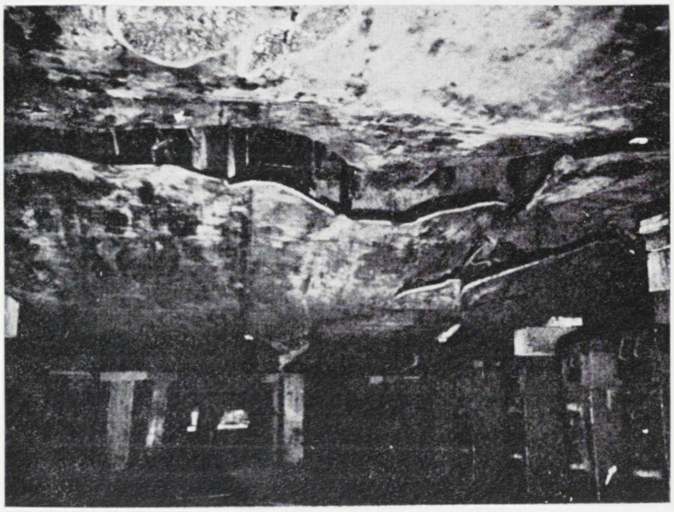


PLATE 18

Another fracture happened in a side tank of a ship classed with the Society during testing. Examination of the bulkhead plate after the failure revealed that it complied with the requirements for "D" quality material and the length of the fracture was under half a metre. The longitudinal was cut in way of the bulkhead and welded to both sides of the bulkhead plating partly with fillet weld and, in way of the outer part, with a full penetration weld. This fracture could have initiated where there was a change in welding, or because the welding was done during the winter or due to shock loads during erection.

Of course, it is impossible to achieve a 100 per cent guard against failure, but by effective control they can be reduced to a minimum. Careful measuring of units before erection reduces trouble arising from bad fitting and contributes to optimum production speed at lowest cost, but it should not be forgotten that quality control must ensure that it maintains the desired standard and quality requirements in all other respects (Ref. 17). Misalignment means lower production speed and therefore the yards are usually very careful, but serious flaws in welds do not have the same effect and there-

fore control of welding may be overlooked by the builders. Examination of the welding after it has been completed is usually too late to find all the defects which are clearly shown in Plate 19 as incomplete penetration and fusion, slag inclusion and cracks, but nevertheless has an acceptable outward appearance.

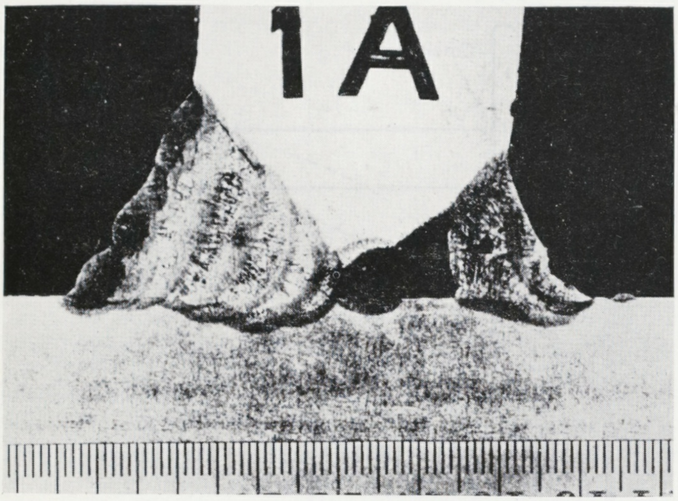


PLATE 19

The Japanese must be congratulated on being the first country to work out detailed tolerances with regard to workmanship and giving detailed directions for remedying defects. Effective Control Departments were established and also the workers took part by establishing discussion groups to identify problems and work out solutions. In England shipyards sometimes employ an Inspector to ensure that the welders maintain the required standards. In Sweden it is the foreman's job to ensure that the welding is of the standard that is required and this practice is not regarded as a satisfactory arrangement in line with modern control techniques where quality control, exercised by staff outside the control of the production management, is required. Unfortunately, carelessness and poor training are not uncommon in shipbuilding, although the piece rate system may have some influence in this.

Use of wrong electrodes, welding in the rain and welding gaps which are too wide are a few of the more common examples which the Classification Society Surveyors come across, together with completely unwelded gaps found during the final inspection revealing only too well the unsatisfactory situation in some shipyards.

CORROSION DAMAGE

General reduction in thickness due to corrosion is not a matter which can be described as ordinary damage in the accepted sense. However, the reports of Surveyors sometimes indicate fast and very severe corrosion which must be regarded as damage. The reports which were examined showed that five tankers and four bulk carriers had such corrosion mentioned, some to web plates of webs and bottom transverses, especially at notches and near connections where the stress levels were high. That this type of corrosion is often found in conjunction with fractures and buckling is well known from other reports and there is a clear indication that a high stress level gives a faster corrosion speed. The thinner the plate the higher the stress and the faster the corrosion seems to be. Deterioration of about 40 per cent of the original thickness over four years of the web plate has been reported on ships classed with other Classification Societies. Previous reports have indicated that corrosion speed actually accelerates, but such an interpretation cannot be made from the Society's reports.

On some larger tankers, not classed with the Society, there was a failure which showed the connection between stress level and corrosion speed in the two side tanks used for water ballast. The longitudinal bulkhead was always under pressure, from the centre tank in the loaded condition and from the wing tank in the ballast condition. Grooves along the longitudinals on the bulkhead appeared as shown in Fig. 49. After about ten years the longitudinal bulkhead had to be renewed. A similar situation arose on the longitudinals in the after fresh water tank on a tanker built to Class.

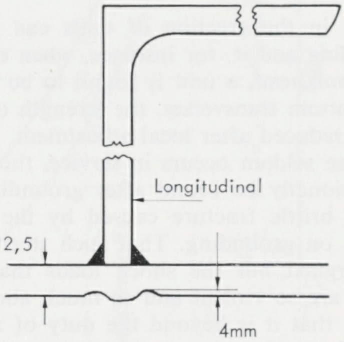


FIG. 49

There was a report that after four and a half years' service there was 6 mm. local wasting on the web plate of a side water ballast tank on a bulk carrier. Ballast tanks which are not protected can, in stressed areas, have a very high corrosion speed especially if they carry oil cargoes as well.

Most of the damage reported from corrosion has occurred in way of horizontal flanges and bottom plates inside the cargo tanks. One tanker has reported a wastage of up to 4 mm. in four years on the bottom shell. Plate 20 shows the

PLATE 20

bottom shell plates which were rejected from an old small oil tanker. Pitting is serious in that it is a starting point for major failures and consequently must be kept under control. It is important, therefore, that during Special Surveys, that the inner bottom plating is carefully examined especially on the older ships which had a bigger sag, and therefore higher stress, in the plating than is usual today.

One ship, it was reported, had external corrosion on the bilge strake in different places of 8 to 10 mm. over a period of two years. This sort of corrosion is well known in Scandinavia due to ships operating in icy water. Ice rips off the protective paint leaving the steel plates and welding bare in sea water, creating galvanic action which corrodes away the weld metal.

Both internal and external protection against corrosion may be installed and as previously stated, approved internal protection against corrosion merits the notation (cc) (corrosion control) in the Register and certain reductions in scantlings may be permitted. Many shipowners hesitate to fit such protection due to the cost, even though extended dry-docking intervals may be allowed providing the special requirements are met.

However, an extensive survey of actual corrosion rates for different members in tankers is at present being undertaken. It is to be hoped that this will give some clear indications and will simplify the decision on corrosion allowances and/or painting.

FAILURES

Some unnecessary failures that are the result of carelessness and thoughtlessness are of interest.

Plate 21 shows a vertical stiffener with sniped face flat and it can be seen how the web has already yielded, during building, due to the weight of the stiffener itself. The fact that this stiffener was made of stainless steel did not improve the case. During erection care must be taken that each prefabricated unit is strong enough to support its own weight to avoid buckling.

Plate 22 indicates a brittle fracture in the deck of a 37,000 tons dwt. bulk carrier built in 1966, starting at a notch that had been created between a $1\frac{1}{2}$ in. thick doubler, fitted to compensate for four holes and another welded doubler below a stanchion that had been fitted about 1 in. away. The deck plating was $1\frac{1}{2}$ in. thick "D" quality steel and samples were taken from the deck plating and longitudinals and the following facts emerged. The deckplate had a percentage of carbon and manganese that was higher and the impact strength was lower than the Rule requirements.

PLATE 21

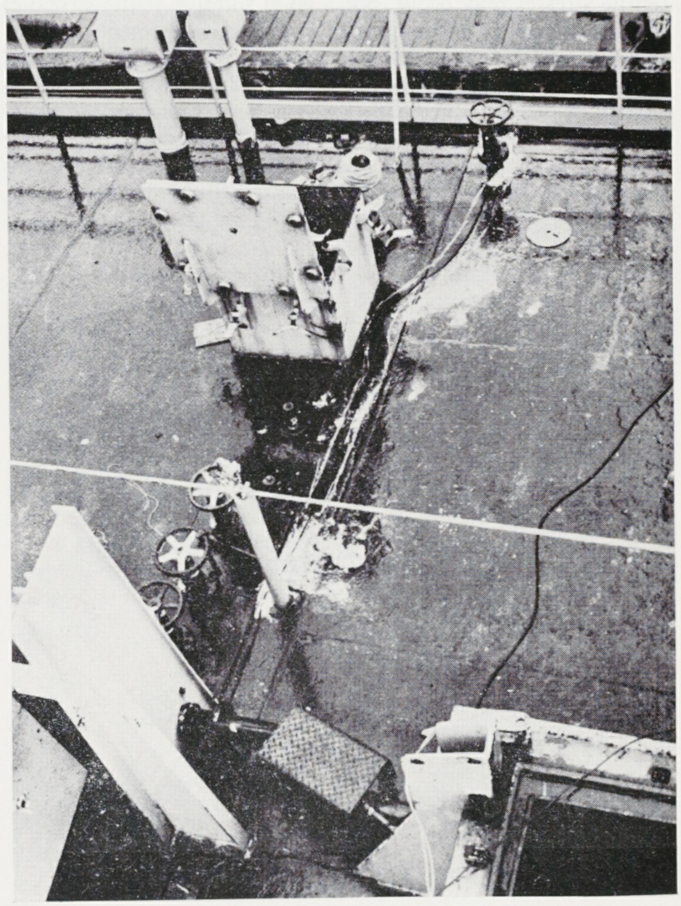


PLATE 22

The rolling direction of the plate was placed athwartships instead of in the direction of the fore and aft main stress, which is normal good practice. The inboard end of the fracture ran into the low stressed deck between the hatches where it stopped, whilst the outboard end ran towards the "E" quality steel stringer plate where it was arrested, passing through seven deck longitudinals, four of which had a fracture along the weld or near to it. These welds were found to have a serious lack of penetration, indicating poor workmanship. Sometimes the residual stresses prevent a fracture from passing a weld and may even stop it but in this case they were insufficient although it is interesting to note that the fracture passes behind the access hatchway. The weather, as is usually the case, contributed towards the failure with the wind blowing 8 to 10 Beaufort at a temperature of about 10°C. This went on unabated until the ship reached port. The length of the fracture in the "E" quality steel was 2 in. on the first day, 4 in. on the second day and 8 in. on the third day when the ship reached port. The still water bending stress was 400 kg./cm.^{2}.

Fractures caused by stress concentrations due to lack of continuity in the structural members of one type or another are always referred to in a paper of this kind. Fig. 50 shows a deckhouse front with a girder below with the theoretical improvement obtained by fitting the brackets shown dotted as indicated by lines a and b. Brackets are normally fitted in way of girders, but they should be placed below each load bearing stiffener and the doubler shown is unsuitable when tensile stresses may occur, but a good solution if the structure is in compression and there is a risk of misalignment.

Finally, attention is drawn to a failure which has occurred in one of the larger passenger ships and is also applicable to smaller passenger ships. Cracks have been found in the deckhouse forward side plating in way of window corners (*see* Plate 23) as the result of the large vertical reaction forces which occur at the ends of the superstructures due to sustaining hogging stresses in bad weather. The form factor for the small corner radii of 75 mm. has been estimated as about 5,8 and at the same time a $\frac{3}{4}$ in. diameter hole has been drilled in the corner to take the window retainer screws. The form factor for the screw hole is about 12,6 and this implies that high stress concentrations are occurring in an already highly stressed area and as is usually the case panel stiffness was not very good on this lighter type of construction. Repairs were made by fitting thicker insert plates at the corners and eliminating the screw holes, the window frame being still attached to the plating by screwed studs welded on and additional panel stiffening was provided.

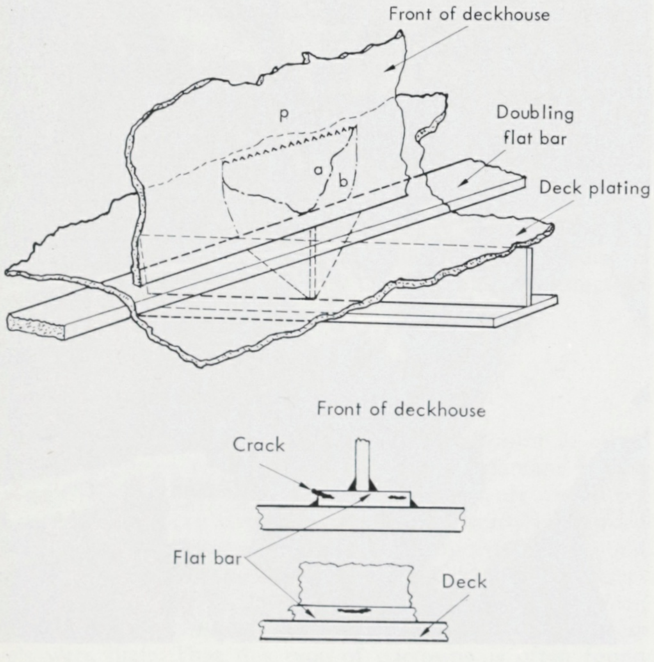


Fig. 50

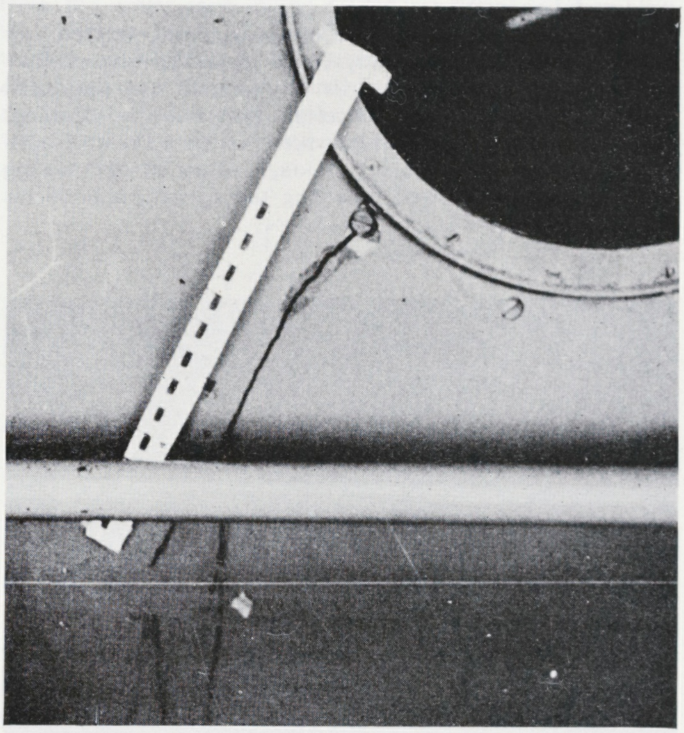


Plate 23

CONCLUSION

This paper has mainly dealt with cases of damage and failure which have been reported from ships either during building or service and although it has been confined to a few particular groups, the number of ships included is quite large. It is quite natural that defects have been found and commented upon, but this fact should not be allowed to colour the overall picture. Whilst it is true that initially there was a lot of damage on large ships, with the advent of computer analysis and the prediction of wave forces the gap between performance requirements and actual capability has narrowed and the overall picture is now one of very positive achievements which should above all be stressed.

A defect is seldom due to one single cause and usually there are several factors contributing and all the factors should be considered as the ships must be capable of meeting the demands made upon them. This concept can be illustrated by the curves shown by Fig. 51 though it should be remembered

that much has still to be done before curves such as these are of practical value to shipbuilding. There are many problems that have to be solved first. The philosophy behind this concept is important and of immense immediate value. It makes it necessary to investigate what factors can influence the shape

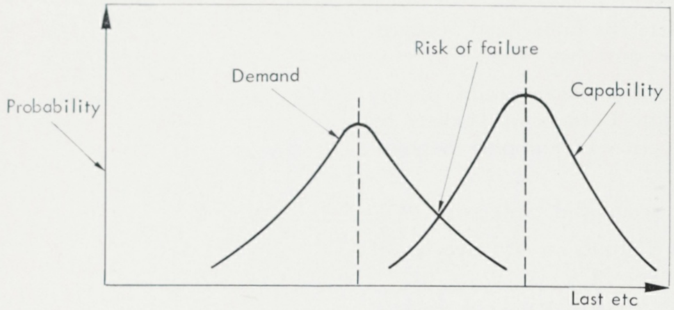


FIG. 51

of the curves and how accurately these factors can be assessed by judgement or calculation and also checked. This will mean that the Surveyors working on scantling rules and plan approval and those outside, who are engaged on the practical aspects of newbuilding and repair, will be required to work in much closer co-operation. They will all have a mutual interest, both in detail design and survey, and in the repairing and reporting of defects.

The ship may be divided into different zones according to the risk of fracture (Ref. 18) and a variation in the acceptable degree of welding defect for each zone suggested. Some countries have, as mentioned previously, prepared their own "shipyard standards" in order to obtain a desired degree of control over what are the accepted tolerances in workmanship.

The tanker web frame stiffening requirements also vary for the different zones (Ref. 4) and it would seem to be a natural development from this that an attempt should be made to regulate more specifically the requirements for design detail with perhaps the most pressing of all these being the cut-outs and attachment of longitudinals as they can amount to nearly 10,000 for the cargo tank area alone on a 200,000 tons dwt. tanker. This could be achieved by having a few standard sketches drawn that would have to be adhered to at different points. Although it seems attractive it could lead to stagnation in the development of new ideas and one is reminded of the old table system. As different yards have a different approach to the design and production of each item, it could be very difficult to write concise rules to cover all eventualities. A better approach, maybe, would require that before a design detail was given approval it should be subjected to full scale tests in a laboratory where the ability to perform both static and dynamic testing and evaluate the results was available. Bearing in mind the resources available by most shipyards and the economic consequences of failure, this approach is not unrealistic. The sort of tests required could be fully discussed, particularly with regard to the important factor of fatigue. It is felt that an attempt on these lines must be made sooner or later.

The Society's greatest asset is the combined experience in service from all the ships that are classed. It is therefore of the utmost importance that this is maintained and that progress is made by improving the facility of collecting, analysing and distributing the results. The quality of each individual Surveyor's report is of paramount importance to the value of the analysis and essential improvements to be made to this system are at present under review at London Office. The issue of more instructions is not something that should be done without hesitation. Active and continuous education, aimed at ensuring that everyone understands what is required, and how the information is used, is of great importance. The selection of what is to be reported will be decided in the circumstances by the Surveyor on the job and it is understood that instruction of what is required is part of a course at the Society's Crawley Training Centre.

It is hoped that this work will be supplemented by giving lectures and running special courses at the Outports. However, the reports of Surveyors alone are insufficient and it is pleasing to know that shipyards and shipowners are to co-operate by keeping us informed of their experiences.

The information which has formed the basis of this paper has been collected for the most part from actual ship reports and from the special damage files at London Office whose staff have been most co-operative. The statistical investigation, which formed a part of this paper was carried out entirely by them. The Outport Staff have also helped by sending press cuttings, drawings and letters. It is impossible to single out by name and personally thank all those in the Society whose help and team work has been of great assistance.

Thanks are also due to some Swedish Shipping and Marine Insurance Companies for valuable information that has been made available.

Most of the original sketches, showing the damage and the tables, were drawn by Peter Härden and Per Ekberg, students at the Gothenburg University of Technology.

This paper was originally prepared and presented in Swedish for a Scandinavian audience. The translation and editorial alterations necessary have been made in headquarters. This has been a difficult task and we fully appreciate the great effort made by Mr. J. J. Mota and Mr. D. H. Clarke as a further example of the excellent co-operation within the Society.

REFERENCES

1. Structural Analysis of Bulk Carriers. Lloyd's Register of Shipping Report No. 5081, 1971.
2. Calculation of Wall Pressures in a Tank due to Movement of Liquids. Lloyd's Register of Shipping Report No. 5108.
3. Effective Breadth of Face Plates for Fabricated Sections. Lloyd's Register of Shipping Report No. 5088.
4. Technical Memorandum No. 2. Determination of the Scantlings of Primary Webs and Girders in Tankers by Direct Calculation. Lloyd's Register of Shipping. September 1969.
5. Longitudinalgenomgangar. A Svennerud Göteborg, 1971.
6. Study of Damage in way of Cutouts in Transverses of Large Tankers. SNAJ. September 1971.
7. Test of Inclined Longitudinals. Lloyd's Register of Shipping Test Note No. 45, 1972.
8. User's Manual. Calculation of Local Panel and Stiffener Collapse using Plastic Design (programme L.R. 330). Lloyd's Register of Shipping. June 1972.
9. Buckling as a Mode of Failure in Ship Structures. J. I. Mathewson. Lloyd's Register of Shipping Staff Association Paper, 1971.
10. Vibration in the After-Body of Ships. J. W. E. Patterson. N.E.C.J. Trans. 1971.
11. Ship Vibration. A. C. Viner. Lloyd's Register Technical Journal. April 1969.
12. The Structural Design of the OCL Container Ships. R.I.N.A. 28th April, 1971.
13. Design Procedure. Int. Ship Structures Congress. Committee Report 10. Oslo. 1967.
14. Lamellar Tearing in Welded Steel Fabrication. The Welding Institute. 1972.
15. Lloyd's Register of Shipping's Approach to the Control of the Incidence of Brittle Fracture in Ship Structures. Buchanan, Jensen, Dobson. I.I.W. Kyoto. 1969.
16. S.S.F. Kälsvetsning av Shop-primerbehandlad Plat. N. Eftring. Göteborg. 1970.
17. Tolerances and Quality Control in Hull Construction Work within Ship Building. O. Rendbaeck. Technical Association in Naval Architecture. Köpenhamn. 1970.
18. Views on Quality Control on Welding in Shipbuilding. Leide, Johansson, Voigt. I.I.W. Lausanne. 1970.

Printed by Lloyd's Register of Shipping at Garrett House, Manor Royal, Crawley, Sussex, RH10 2QN, England

Lloyd's Register Technical Association

Discussion

on

Messrs. S. Janzén and O. Nilsson's Paper

HULL DAMAGE IN LARGE SHIPS

Paper No. 1. Session 1972-73

The authors of this paper retain the right of subsequent publication, subject to the sanction of the Committee of Lloyd's Register of Shipping. Any opinions expressed and statements made in this paper and in the subsequent discussion are those of the individuals.

Hon. Sec. C. Cummins
71, Fenchurch Street, London, EC3M 4BS

LLOYD'S REGISTER TECHNICAL ASSOCIATION

PAPER No. 1 SESSION 1972–73

HULL DAMAGE IN LARGE SHIPS

by S. Janzén and O. Nilsson

ERRATA

Page 21, Fig. 28 has been amended to:—

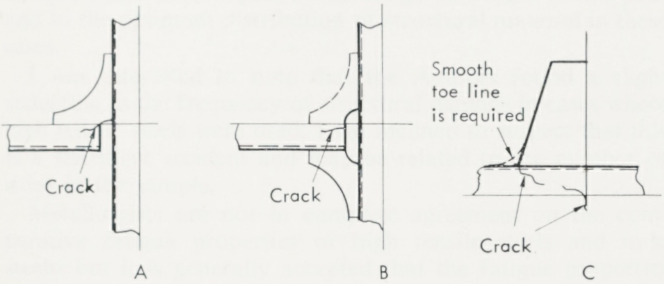


FIG. 28

Page 22, the diagram of Fig. 31 has been amended to:—

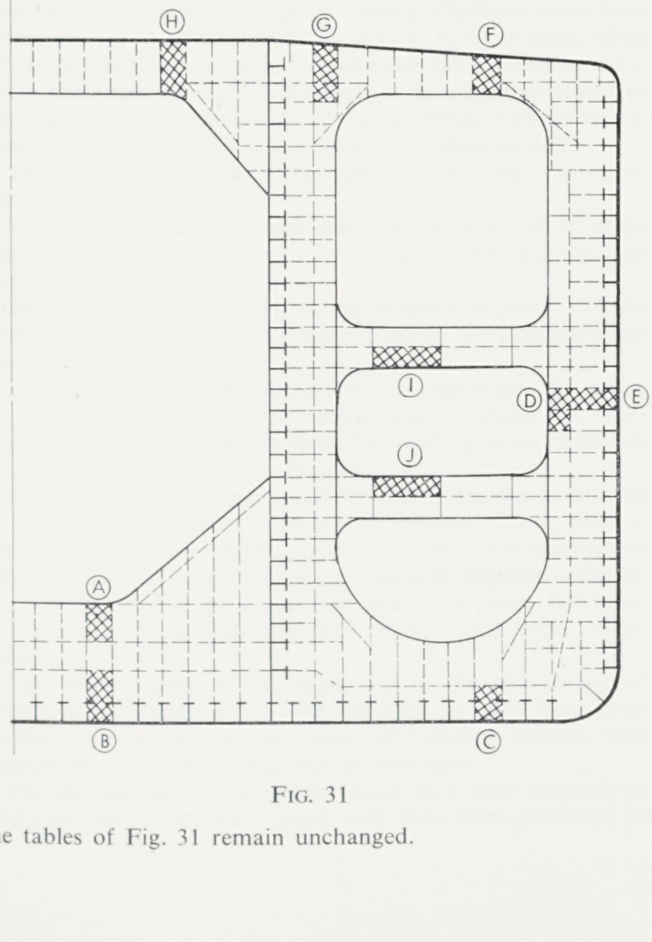
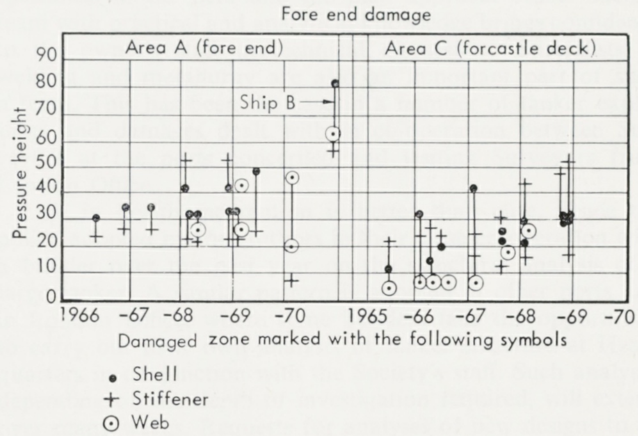


FIG. 31

the tables of Fig. 31 remain unchanged.

Page 27, Fig. 37 has been amended to:—



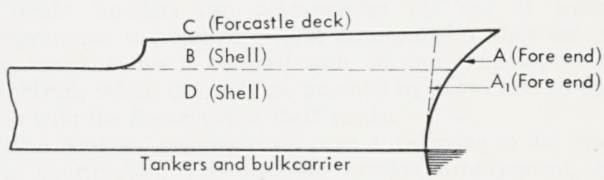


FIG. 37

and the penultimate sentence of the left column has been amended to read:—

Stems of the type A_1 have given good service as far as is known.

Discussion on Messrs. S. Jansén and O. Nilson's Paper

HULL DAMAGE IN LARGE SHIPS

Mr. J. McCallum

Mr. Janzén and Mr. Nilsson have carried out an investigation of structural failures which merits considerable attention and I would like to comment very briefly on one or two points of interest.

It is clear that so far as tankers are concerned, the frequency of failure is highest at the ends of the ship and it may be deduced that acceleration forces, partly due to vibrations, are the cause, resulting in early fatigue fractures. With such large vibrating masses, it is more necessary than ever before, that adequate attention be paid to the design of welded connections and to the optimum distribution of structural material in these cases.

I was interested to note that the Authors found a slight reduction in the frequency of structural damage in cases where high tensile steels were used. I am inclined to suspect that this is a statistical accident and may be related to the number of ships in the sample.

Metallurgists are not in complete agreement on the comparative fatigue properties of high tensile steels and mild steels, but it is generally accepted that the fatigue properties in the heat affected zone of a weld are reasonably constant whatever the parent metal may be. When the stress levels are raised, that is, when high tensile steels are used, the welded end connections must be designed and the work effected with the utmost care.

Most of the problems of the theoretical distribution of stresses corresponding to a given loading condition have been solved, or are in process of being solved. In these days, when powerful analytical procedures and even more powerful computer hardware are at our disposal, it has become easier to use these processes than to build, for instance, a photo-elastic model, to find out what is happening in a difficult area.

This is not the whole story, however, as I am sure most people here will agree.

Firstly, plastic deformation has always occurred in ships and, in most cases, this will happen before the ship takes to water.

Secondly, much of shipbuilding practice depends on the ductility of materials and we have to revise our practice when thicker steels are used.

Thirdly, it is almost impossible to reproduce the effect of residual strains due to welding and undoubtedly, well-established shipbuilding practices, like cutting access holes in bulkheads, are contributory factors.

The recording and analysis of structural damage is an area in which the shipowner, through his superintendent, plays a very large part. One of the major areas in which shipowners can provide vital information unobtainable anywhere else in any detail, is that of corrosion. We have been fortunate enough to have had offers in this respect from large tanker owners.

The major theme of the paper lies in the importance of design of structural detail and those of us who have been involved recently in the problems of lamellar failures well appreciate the attention required in this area.

The Authors are to be congratulated on a very painstaking and excellent work which could only have been produced in the context of this Classification Society. It will form an important part of the annals of our Techinical Association.

Mr. W. H. Marsden

The attendance and the number of contributors at the reading of this paper, certainly indicated its value. The Authors are to be congratulated on the scope of their paper and admired for its presentation in English.

Similar to the person, who likes to read the end of a novel first, I would like to refer to the conclusion where the Authors have a formula for success, in advising closer links between specialists in the field and the plan approval office. Such a team with practical and analytical knowledge brings confidence to the owner's staff in technical discussions. Specialists of welding and metallurgy are also an important part of such a team. This has been the case in a number of tanker explosions and damages dealt with in co-operation between Surveyors at the ports concerned and visiting Surveyors from London Office.

Like in health, prevention is better than cure, hence the policy adopted by the Authors in their close co-operation with a builder over the past year on the structural analysis of a large tanker. A similar pattern is adopted in other ports and in London Office, where some builders take the opportunity to carry out their own analysis of tanker structure at Headquarters in conjunction with the Society's staff. Such analysis, depending on the depth of investigation required, will extend over many weeks. Requests for analyses of new designs to be completed within days, I am sure would result in damage indicated in Fig. 27 being repeated.

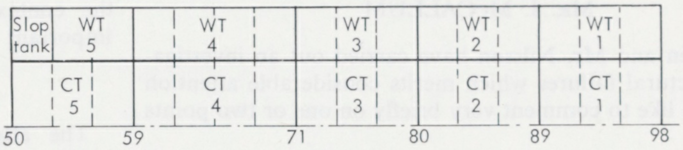
Whilst builders can acknowledge the use of technical programmes to solve structural arrangements, they are more impressed if this is coupled with an understanding of their problems, which can only be attained by very close co-operation with the Surveyors at their yards.

The Authors' comments on page 4, referring to the straight line construction and separate bracket arrangement, is in association with Scandinavian production. The detail analysis of sub-structuring and photo-elastic tests which has been carried out on separate brackets, indicates the amount of design work necessary. Figs. D.1 and D.2 illustrate damage in way of separate brackets commented on by the Authors on page 26, prior to analytical methods. The classic case of the end separate bracket of the bottom centre girder laying on the shell, needs no further comment.

The straight line construction with separate brackets is certainly popular for fabrication reasons for a ship with cross-ties. The design of separate end brackets for the lower portion of the wing tank side transverses of a ship without cross-ties and for the deep bottom transverses of centre tank, have not fully attained the same popularity although the advantages in fabrication are certainly the same.

On page 21, reference is made to the stiffer support points of the bottom and side longitudinals at the transverse bulkheads. Do the Authors consider that these items should be included in the grillage analysis to obtain the true load on transverses, especially if larger transverse spacings are considered?

Type	No of fractures	Extent frames	Length
1	33	72–97	Small to full length of connection
2	25	72–97	Small fractures
3	17	72–97	Small to 1 200mm
4	8	75–91	Small to 50mm
5	1	75	Small
6	2	76&78	150mm
7	1	78	150mm
8	2	84&96	200&100mm
9	1	96	50mm



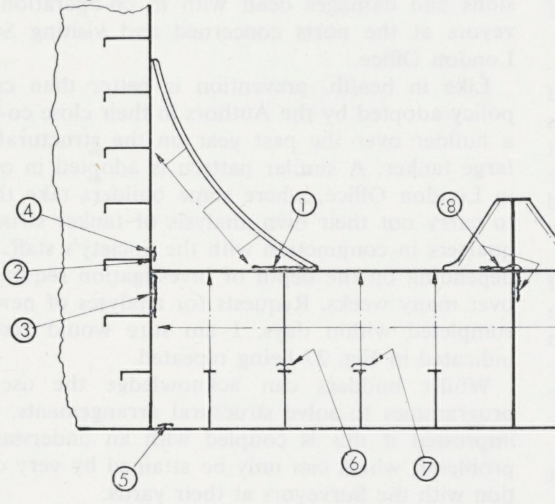
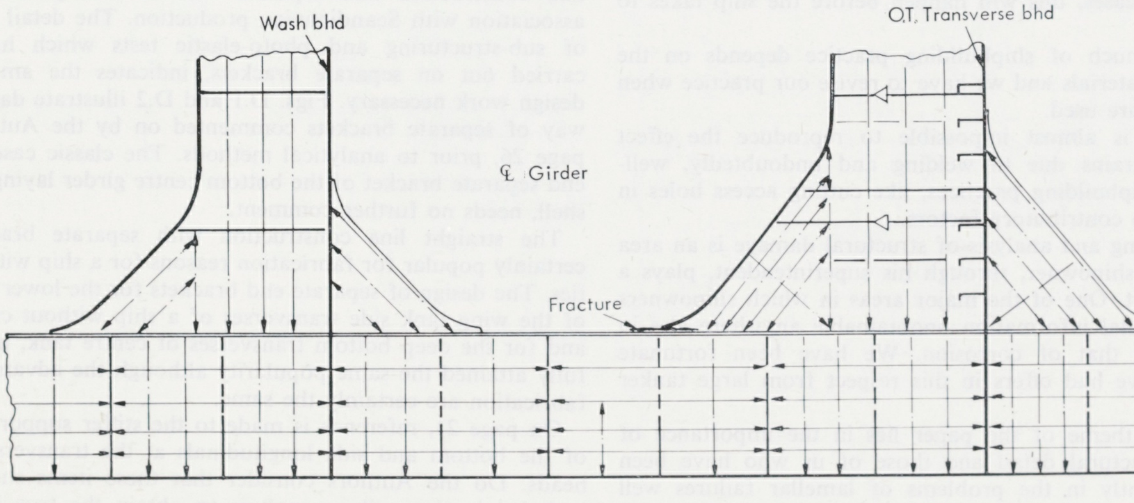


FIG. D.1



Fractured and buckled bracket in No & 2 tanks, bracket buckled in remaining tanks

FIG. D.2

Concerning the practical performance between 'L' and 'T' profiles also referred to on page 21, it is, of course, of interest to note that the depth of bottom longitudinals for the latest generation of V.L.C.C's can vary from 800 to 1000 mm deep. Perhaps these would be considered as girders on smaller ships and Rule tripping brackets would be required, the bracket spacing depending on whether the face is assymmetrical or symmetrical. The present buckling and torsion criterions are, of course, intended to avoid these tripping brackets.

It will be noted in the paper, that except for the collapse of the cross-tie (Fig. 1), which was not to the Society's standards, generally the damage is due to buckling and the Authors have clearly emphasised the importance of this criterion. Work is still progressing in this field as indicated in the recent issue of the interim buckling standards, incorporated as a letter to Technical Memorandum No. 2.

Buckling damage has also occurred to the fore peak centre line wash bulkhead of V.L.C.C's. The width of the flat of bottom distributes the load directly to this wash bulkhead, whilst on the smaller tankers the U shape ensured the side shell absorbed the greater load. The shear buckling stress of the panels should be at least 20 per cent greater than the Rule shear stress at that position. Account should be taken of shear rigidity of the bulkhead when considering the thickness of effective plating and the proportion of the shear load which the wash bulkhead absorbs due to the fuller form.

Incidences of damage at cut-outs for longitudinals and stiffeners are still occurring in the size of ships referred to by the Authors. This type of failure cannot be related only to statical loading, as plan approval letter 1037 refers, but it is of interest to note that the load transmitted by a bottom longiudinal in vicinty of a notch, for an empty tank condition with full draught, can vary from about 50 tons in a 50 000-ton tanker to 145 tons on a 300 000-ton V.L.C.C. Fig. D.3 shows similar damage occurring at the transverse bulkhead stiffener.

Particular attention is also required to be given to the docking girder, as damage has occurred due to lack of appreciation of the buckling criterion of this member. The deep centre girder is becoming a rare animal and its exclusion must ensure that owners are advised of the docking condition and block arrangements which the smaller docking girder is suitable for.

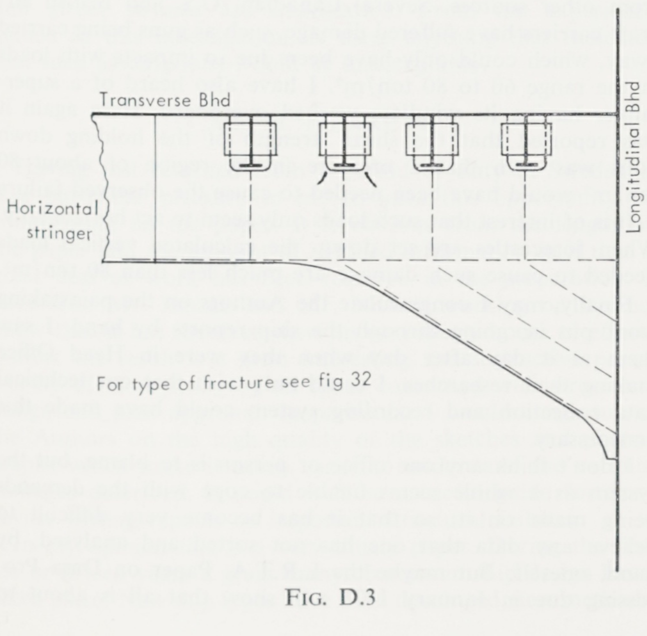


Fig. D.3

I apologise to the Authors for this rather long contribution but I write it as a tribute to their classic paper which I know will be well received by all.

Mr. N. S. Flensburg

It has been clearly demonstrated by Mr. Janzén and Mr. Nilsson how important the structural design and particularly the details are on large ships. From the Register Book, the number of ships in service over 200 000 tons deadweight was 205 (203 of which are tankers) at the end of 1971.

We have to realize that the damage survey, CSH or SS of these large ships is a new experience for most of us and we have to consider how the surveys should be carried out. In this context I will raise a few points.

It may be that for each large ship a Survey Book should be prepared by the plan approval office and placed on board. Such a book could be useful for the Surveyors examining the ship. Apart from main structural plans and loading conditions it could contain useful information such as: highly stressed areas, details of special interest, dangerous areas from corrosion point of view, etc. The Surveyors should indicate with sketches in the book any interesting weaknesses, they have found during the surveys. Head Office must, of course, have a copy of the up-to-date Survey Book. The same also goes for the plan approval office, as many yards build a large series of sister ships and the service experience from the first vessels must be incorporated on the later ships.

The facilities for surveying the cargo tanks and holds should be agreed upon with the owners and builders. A plan showing staging and other facilities should be submitted for approval.

The Special Survey of large ships is a very demanding and laborious task and should, in my opinion, be carried out by survey teams specialized in such jobs. These teams or flying squads should be sent from Head Office and from a few centres in Europe and Far East. Each team should contain specialists of hull structures and people who have up-to-date plan approval experience of the type of ship they will survey.

The team should, of course, be familiar with the structure of the ship and its history before going on board and carry out buckling and other strength calculations on the spot. It will be easy for these specialists to fill in the Survey Book on board. This survey concept will probably be more expensive than the present system, apart from the high travelling expenses. I am convinced that the owners will pay an increased fee for the prompt and improved survey, bearing in mind that the idle cost per day for a 200 000 ton deadweight tanker is of the order of at least £5000. The public relations value and the knowledge gained by the Society should also be considered.

If this scheme is followed the Report 8 should, in my opinion, only cover the legal classification aspect. The report should be accompanied with the sheet from the Survey Book and other information useful for the Technical Records and Hull Structures Departments. Obviously, very rapid reporting is necessary to give an early warning of any structural weaknesses. Finally, I would emphasize how important it is that the Surveyors write reports and sheets in such a way that they could later be used for further analysis. Some guidance with examples from Technical Records should be most useful.

Mr. J. I. MATHEWSON

This paper contains a very considerable amount of information, and the Authors are to be congratulated on the efforts they have devoted to presenting the information more widely.

In assessing the significance of the damages, it is helpful to summarise these in two particular categories.

Those which are largely attributable to inadequacy in overall design principle, such as shown in Plates 1 and 2, Figs. 1 to 8, etc., and those related to inadequate attention to structural detail, particularly connections, of which Plates 3 to 6 are typical examples. The former highlighted the need for a more fundamental approach to scantling approval using direct calculation methods by computer. This approach has already been implemented in the Society for tankers, container ships, bulk carriers, etc., and is currently being extended to cover a wide range of ships and components.

The structural details can also be improved by utilising sophisticated analysis techniques at the design stage, but good workmanship, sound production procedures and adequate quality control are also essential. In many cases, the connection is designed primarily for ease of production with structural strength a secondary consideration.

Conscious of the serious consequence of such failures and their implication where standard series are affected, the Society has set up in Hull Structures Department, Headquarters an early warning system for the identification of such defects in ships less than five years old. At the same time the co-ordination of effort to diagnose the cause and effect a solution is centred in the same area.

The key to the minimisation of defects lies in creating an awareness within the Surveyor of potential problems and their root cause. This paper has gone some way to achieving this.

Mr. A. K. BUCKLE

Reference is made on page 1 to major damage to ships' side structure occurring from 1965 onwards.

I think that in line with L.R. traditions we can claim to have been first in the field, for Mr. J. M. Murray gave a lecture to students at Trondheim in September 1964 (*see* L.R. Technical Reprint No. 33) in which he included an excellent photograph of what was described as 'Serious and inexplicable failure' when a 70 ft×30 ft panel of shell broke adrift. From the description of the subsequent survey it appears to have been a perfect example of the type of failure shown in Sketch 1 of tonight's paper, but some three years ahead of its time.

On page 12, reference is made to decks between hatchways and it would be of interest to know if the recent damage to the corners of hatches on Great Lakes bulk carriers fits the same pattern. It is understood that this damage followed an increase in the hatch widths, but as it is also understood that consideration is now being given to increasing hatch lengths by some 350 per cent any lessons that can be learnt from seagoing ships should be carefully applied.

On page 14, Table IV, we have a typical set of data to that kept by many head office Surveyors. Unfortunately this table is of little use to one's colleagues without interpretation, e.g. what is the ratio $\frac{\varepsilon}{D}$ actually representing and are the thicknesses those of shell, decks or what? The top diagram, for instance, has four thickness values but five main structural components. Similar remarks apply to certain other tables.

On page 21, reference is made to Technical Memo No. 2 and I would take the opportunity to make a plea to my colleagues to make sure that, when they are using Technical Memoranda, Technical Reports, Plan Letters and the other assorted output from Head Office, the copy they are using has been properly updated. This is especially so with works such as Technical Memorandum No. 2 which has now been overtaken by Rule Amendments in a number of places without itself having been specifically updated.

On page 23, Figs 32 and 33 show the high incidence of damage in the region of the water line. Has any attempt been made to ascertain how much of this damage is due to causes other than wave impacts? Mention has already been made by other contributors to damage occurring during launching, docking and tank testing and to this I would add that damages due to fender loads and to tugs pushing against the ship would appear in just the areas shown in Figs. 32 and 33, as occurring above the cross-tie. I might add that large modern tugs have such high bollard pull values that they can cause indentations by a steady push without impact loads occurring.

Many tanker companies are now being forced, by circumstances, to add owner's extras to shell stiffeners and to mark the stiffened areas with painted targets for tugs to push against.

Scantling calculations from first principles are the only proper way to design large ships, but all the loads must be taken into account. No matter how good the program used on the computer, the output can't be better than the loading input accuracy. Harbour and docking loads are so large, so different from seagoing loads and affect so large a proportion of the ship, that they can't be properly catered for as an afterthought.

On page 27, Fig. 37, two stem lines are shown on the sketch. I think the straight (dotted) bow line should be marked A_1 and that the reference to stem type A in the text (9 lines below the figure) should also read A_1.

Still with reference to Fig. 37, while the heads of up to 80 metres may seem unbelievable, they do have co-relation from other sources. Several Canadian, U.S. and British aircraft carriers have suffered damage, such as guns being carried away, which could only have been due to impacts with loads in the range 60 to 80 ton/m^2. I have also heard of a supertanker having its windlass washed overboard. Here again it was reported that the shear strength of the holding down bolts was such that a pressure in the region of about 80 ton/m^2 would have been needed to cause the observed failure

It is of interest that such loads only seem to act horizontally. When forecastles are set down, the calculated vertical loads needed to cause such damage are much less than 80 ton/m^2.

Finally, may I congratulate the Authors on the painstaking work put in, going through the ship reports by hand. I saw them at it day after day when they were in Head Office making their researches. I could only wish that our technical data collection and recording system could have made this unnecessary.

I don't think any one office or person is to blame, but the system as a whole seems unable to cope with the demands being made on it, so that it has become very difficult to believe any data that one has not sorted and analysed, by hand, oneself. But maybe the L.R.T.A. Paper on Data Processing due in January 1973 will show that all is about to

sort itself out. However, like Mr. Flensburg, I feel that something more radical may be required than the computerisation of existing data.

Mr. F. O. THOMSSON

Before going into questions, I would like to congratulate the Authors for a most interesting paper. As mentioned in the introduction, this paper, originally presented in Swedish to a Swedish audience, was produced at the Gothenburg office where, from my experience, teamwork is one of the main principles. I think this is an excellent example of what can be done by an outport office.

I also think it is important that the outport offices are encouraged to carry out investigations like this especially now when these offices increase their facilities to carry out more complicated plan approval work based on computer and direct calculation procedures. By producing and reading papers locally this undoubtedly creates a good image for the local offices.

Going back to the actual paper, it is interesting to see that the Authors have taken up the demand capability approach. The Authors state: 'These concepts can be illustrated by the curves shown in Fig. 51 though it should be remembered that much has still to be done before curves such as these are of practical value to shipbuilding'. Would the Authors say they have become more aware of this problem after looking into the damage records? Could they also indicate if they can see areas where drastic alterations are required in our present damage report system in order to suit the demand capability concept? Also, do they have any concrete proposals to make, in order to speed up the practical use of these concepts?

Regarding the proposal for full scale tests of details before approval, I think that this could be advantageous in many cases, as the ultimate aim is always to establish the probability of failure not the probability of exceeding a certain stress. Areas where it seems to be possible to use such an approach is, for example, the connection of longitudinals to supporting structure. I can see possibilities to derive load spectrum for such a test under the assumption that there is no relative displacement between transverses and that the longitudinal hull girder stresses are disregarded. From the experience gained in this investigation, is there anything that indicates that such assumptions would be unacceptable?

Mr. M. MERRETT

Having just returned from a period of duty in Sweden it is a particular pleasure to me to have this opportunity of commenting on the paper. It is obvious from the length of the paper and the amount of detailed information in it that a great deal of work has been required in the preparation. I have seen Mr. Janzén and Mr. Nilsson working on it, and know that it has involved them in very many hours of effort. I think the result is a most interesting and instructive paper worthy of close study by all those concerned with structural design and plan approval. In particular I would congratulate the Authors on the high quality of the sketches and photographs which make it much easier to understand the various damages described. It could well be a useful guide for Surveyors writing reports on important structural failures.

In my opinion this is a very timely paper. During the last ten or fifteen years a great many changes in ship design have taken place. New ship types have been developed, new methods of construction and assembly have been devised and, of course, as we all know, the size of ships has increased tremendously. The traditional methods of evaluating scantlings based on simple formulæ and rather conservative stresses, based on previous experience. which worked quite satisfactorily for the smaller and more conventional ships, were found to be not completely satisfactory for larger ships. Extrapolation from the old rules was uneconomical and not entirely adequate to ensure complete freedom from structural failures. Due to the great capital investment involved with these larger ships, in order to eliminate non-essential weight and reduce the problems of handling very heavy sections, new methods of structural analysis were demanded. Another important factor leading to this same conclusion was the increased competition from other classification societies which made it essential to adopt the more sophisticated methods of structural analysis which, thanks to the computer, were then becoming available.

The application of these new methods, whilst a logical and necessary development, may not solve all our problems. Successful structural design is only proved by trouble-free service. It is therefore most important that experience from vessels in service should be very carefully collected and analysed so that any deficiencies in the design techniques are quickly brought to light with necessary changes made. The Society's reports system is one of the main sources of such service experience, but it is important that the information gathered should be made available periodically to those engaged in structural design work. This has certainly been achieved by the Authors of this paper.

Evaluation of the information given in the paper is a difficult task. It is interesting to read the conclusions reached by the Authors, particularly that relating to the effect of computer analysis on the incidence of damage. If one looks at Table IX on page 19, it will be seen that the number of damages in transverse rings and longitudinal girders in tankers built after 1968 appears to be almost negligible. On the other hand few of these ships will have yet come up for their first special survey, and as the designs for them must have been approved as long ago as 1967, it is doubtful whether very much in the way of computer analysis was done at that time. Could the Authors say how many of the ships investigated were in fact subjected to computer analysis, or what other reasoning has led them to the conclusion they have reached? I am inclined to think that it is difficult to arrive at a very definite conclusion on the evidence so far available, but consider that the picture may be clearer in three or four years' time. Perhaps it might be a good idea to have a Part II to this paper, though I hesitate to suggest this to the Authors.

In looking through the paper one is struck by the number of small fractures starting from detail design features or areas of high stress concentration. These may be indications that the detail designs are poor, or they may mean that there are major structural weaknesses—after all, failure must start somewhere. Whatever the significance, it is clear that the elimination of poor detail design features and stress concentrations is extremely important. The suggestion that approval of such features be based on the results from full-scale tests is a novel one which deserves consideration, particularly when it is realised that a particular design of cut-out and longitudinal attachement may be repeated 10 000 times in one large ship.

One of the areas where considerable damage occurs is the aft peak and engine room. This appears to be largely due to

vibration. The Authors point out the desirability of keeping stiffener spans as short as possible and I agree wholeheartedly with this. It would also seem desirable to have some Rule requirements or recommendations concerning the size of plate panels, stiffeners and end attachments, to ensure freedom from excessive vibrations.

Finally, I would like to thank the Authors for a most stimulating paper.

Mr. H. CAPPER

I would like to say a little about corrosion fatigue. In an 80 000-ton bulk carrier, owned by an organisation with which I have recently been associated, severe cracking took place after a short time in the aft peak tank. A comprehensive system of cathodic protection was installed and at the same time considerable structural strengthening was undertaken and the cracking was almost eliminated. It is impossible to say how much the reduction in cracking was due to the corrosion control and how much to the stiffening.

All the same, it is known that cathodic protection increases the life of steel under corrosion fatigue conditions by reducing the potency of the corrosive part of the combined action.

Tables V and VII in the paper tend to show that the incidence of cracking is reduced by corrosion control (presumably by cathodic protection) and by the use of high tensile steel. But it is generally accepted that the life of high tensile steel in corrosion fatigue conditions is very little superior to plain carbon steel.

There is, however, a time factor involved. If local stresses are high, corrosion control will have little effect because the time to failure is short and the use of high tensile steel in these circumstances will be beneficial because of the increased yield stress of the material. If, on the other hand, local stresses are lower and failure takes longer, the effects of corrosion fatigue are more pronounced. In this case, the effects of corrosion control will be more beneficial and the use of high tensile steel of little benefit because its resistance to corrosion fatigue is very little better than mild steel. Due to the time factor involved, maybe we have not sufficient statistical evidence yet to show the effects of corrosion control together with the use of high tensile steel.

Mr. J. R. G. SMITH

A tremendous amount of hard work has gone into the preparation of this paper and the end product is first class.

To my mind, the main lesson to be learned is the importance of a thorough and well organised survey during new construction. As the speed and complexity of new construction increases, so the Surveyor has increasing difficulty in controlling workmanship and structural details. Deficiencies in these items can result in situations as described in the paper. We must bear this very much in mind as the world's leading shipyards begin to press for approval of their own Yard Standards and Quality Control Systems. Whilst I believe that this trend is inevitable and indeed necessary, I would urge that the Society be in a position to carry out such approval in the future by the systematic collection of the necessary new construction data now. My proposals on these matters were included in my contribution to Mr. Nilsson's excellent paper on 'Hull Survey of New Construction in Sweden'.

Finally, I must express my appreciation again for this detailed and informative work.

Mr. HINSON

Table IX would appear to indicate that tankers propelled by diesel engines suffer less damage, particularly at the fore end, than tankers propelled by steam turbines.

This is to be expected. In my experience when a diesel-engined ship runs into heavy weather, particularly with the wind dead ahead, the engine tends to labour and the exhaust gas temperature increases. In order to avoid damage to the engine the power is generally reduced, reducing the forces acting on the hull, particularly those at the fore end.

On the other hand steam turbine machinery usually incorporates gearing with a relatively large polar moment of inertia. The bull wheel, which is attached directly to the propeller shaft, can weigh upwards of 50 tons and this weight is distributed mainly around the rim, constituting a large flywheel.

The way in which the steam turbine produces power is, of course, fundamentally different from that of a diesel engine. The important point here is that a turbine will not overheat when the ship is driven into head seas. Thus the large flywheel and basic characteristics of a turbine enable ships with this type of engine to be driven much harder than diesel-engined ships.

It would be interesting to learn if, in the opinion of the Authors, the cause of some of the damage described in the paper could be attributed to the way in which the ships were operated rather than design and workmanship.

AUTHOR'S REPLY

To Mr. McCallum

Mr. McCallum refers to the statistical tables and the reduction found in the number of failures for ships built in high tensile steel and questions whether the amount of samples is sufficient to allow any significant conclusion to be drawn. We agree that the sampling is small but we are still inclined to believe the statistical results, as they refer to the use of high tensile steel mainly in the deck and bottom area of large tankers and OBO ships, where the type of constructional details, extensive production control and existing loading pattern, may have a beneficial effect.

It is agreed that fatigue is a problem and in this respect it is not only the properties of steel and weld material that count as the geometrical form of the weld and also the environment may have greater influence than the material properties. Whether a 'cosmetic' run by TIG-welding will be used in the future in ordinary shipbuilding is perhaps still an open question as the demands today are not the same as those required by engine builders.

Plastic deformation and ductility of material were mentioned. It may well be that these are worth further consideration as, for instance, in the case of large ships where the transverse stresses have a tendency to increase and thus lead to a higher probability of brittle fracture. However, this might be offset by the more controlled properties of the high tensile steels, correspondingly decreasing the thickness and, luckily enough, the often compressive pattern of the transverse stresses. If consideration is given to the reduction of the longitudinal strength requirements, probably this point and the extent of special quality steels will need further consideration as well.

We are pleased to note the co-operation with the shipowners as the quoted example in the corrosion field indicates. Corrosion is a somewhat underdeveloped subject and we believe that without good co-operation this is almost impossible to clarify.

The frequency of failure at the ends of ships is indeed high. It would probably, as intimated, not be economically sound to cater for the largest predicted forces say at the fore end, but it is hoped that more precise guidance and regulations will be issued. The same applies to the after end where the vibration failure rate needs to be reduced. The difficulties in issuing vibration regulations are appreciated, but if guidance notes are given, we believe that their application should not be left entirely voluntary, as done by certain other Classification Societies. Such a system could easily give the yard an excellent opportunity to charge builder's extra.

To Mr. Marsden

Mr. Marsden has read the 'end of the novel first' and we are pleased that he has noted one of our basic aims, viz. to stress the need for closer co-operation between the different specialists in the field. This is, of course, of fundamental importance and it is thought that the demand-capability concept will give further enlightenment.

The separate (straight line) brackets are certainly favoured in Scandinavia and would probably be used even in a wing-tank without a cross-tie if that latter construction was found desirable. However, there is a strong desire to restrict the size of the face flat bar to prevent the risk for cracking at the ends as mentioned in the paper. This leads to an increased thickness of the bracket plate itself. It may therefore sometimes be more economical to design a transverse with a continuous face flat over the integral 'brackets' at the ends instead of using a smaller separate bracket correspondingly strengthened in way of the transverses and webs. The separate bracket construction with the face flat on top shown in Fig. D.1 should, of course, as intimated, by all means be avoided, as the stress concentrations at the end of the face flat now occurs 'dead on' the outermost highly stressed bracket plate. Compare also Mr. Marsden's Fig. D.2 and the different types of brackets.

Regarding deflection of main supporting members and the consequent re-distribution of loads it will be necessary to consider this in the future. This is illustrated in Fig. D.4 for a vertical web on a bulkhead on a 350 000-ton dwt. tanker. Another builder has re-run the transverse bulkheads in order to estimate the true load from the horizontal stiffeners on the vertical webs and has changed the scantlings requirements accordingly. But the procedure is a laborious task and it is questionable whether it is justified considering the uncertainty in the basically applied loads.

As said in the paper, we were surprised that no particular difference was noted in the practical performance of the 'L' and 'T' profiles. The stress levels must therefore still be fairly modest and anyhow we always seem to rely on plastic re-distribution in ship building. Unless stress levels are considerably changed it seems we are able to accept 'L' profiles without additional tripping brackets. It is illogical, however, to treat both types of profiles the same.

We agree to Marsden's statement that a main cause to structural damages has been inadequate buckling standards and that this has been vastly improved by the recent issue of the interim buckling standards incorporated as a letter to Technical Memorandum No. 2. We are all aware that this standard, which for simplicity is based on a corrosion allowance expressed as a percentage of the actual fitted plate thickness, can be criticized. It is therefore hoped that fixed corrosion allowances can be stated instead, and issued, for different areas of the ship.

Mr. Marsden emphasizes the necessity for closer examination of the fore end to ensure that sufficient shear area is provided. On some of the V.L.C.C's the longitudinal bulkheads stop at the fore end of No. 1 tank and as sometimes no CL bulkhead is fitted in the fore peak, the whole shear force must be taken by the side shell. Luckily enough it seems possible to arrange the loading and general arrangement such that only limited shear forces occur at this point.

Fig. D.3 in Mr. Marsden's contribution is interesting as it shows cracks in the stringer in spite of double lugs and stiffener on top of the vertical stay. It is thought that the nominal shear stress in the stringer might have been rather large or that the cut-out was badly made. We know that Mr. Marsden does not like the straight part of the bottom lower end of the cut-out, but are not in complete agreement with his disapproval. We do agree, however, that a good radius at the corner of the cut out lower part is required. As probably can be seen from the paper, we are much in favour of double lugs and consider this as an overriding requirement due to its ability to reduce the shear deformation in way of the cut-out.

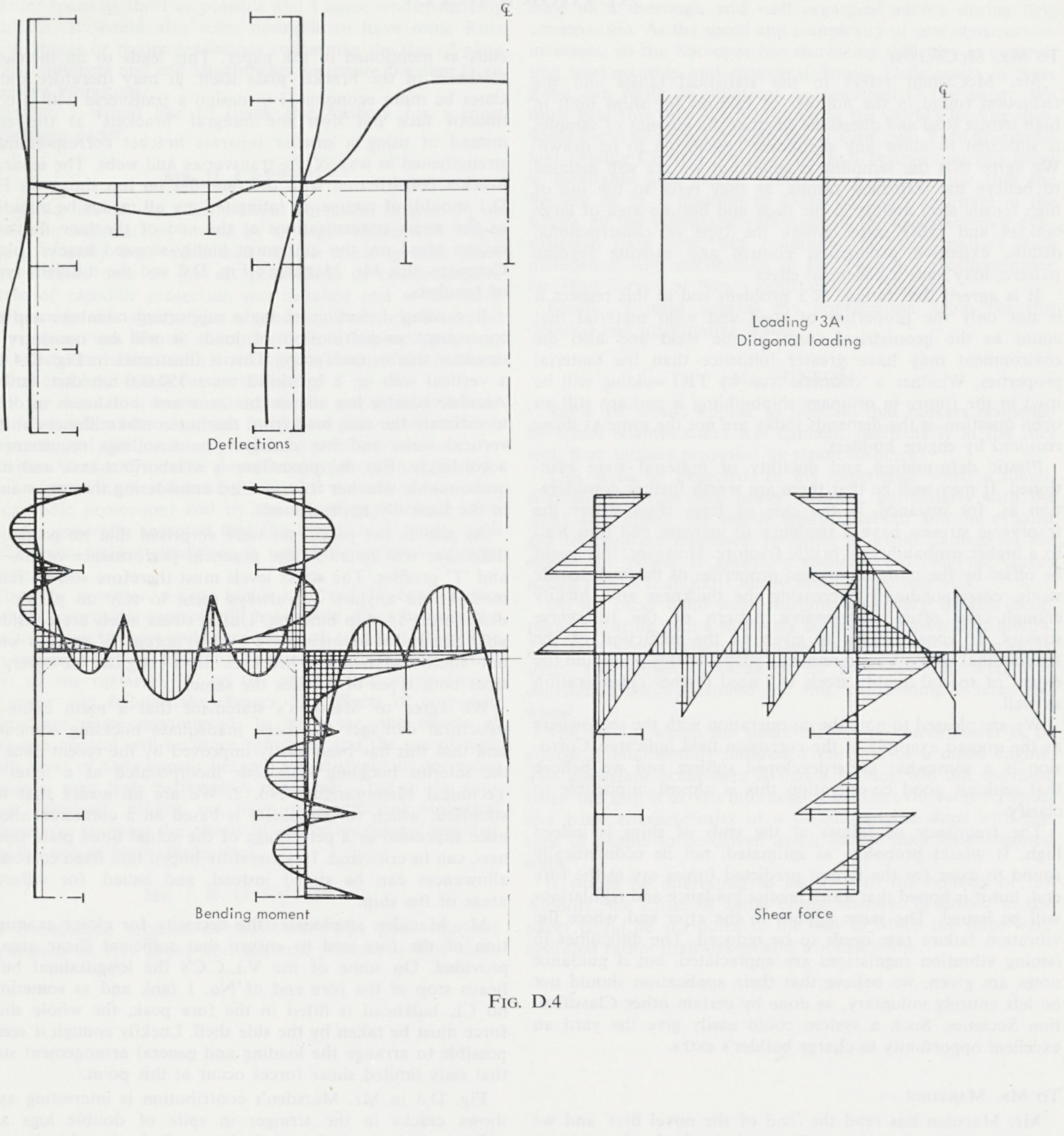


FIG. D.4

This is among others well explained in Reference 6 mentioned in the paper. In way of cut-outs in the vertical web against side shell, it appears essential to avoid cracks in the shell plating itself, and double lugs seem to be the best way to prevent this.

As to Fig. 32 in the paper Fig. D.5 shows the situation for a few ships recently investigated. In preparing the table in this figure indicating the crack lengths, we fully appreciated the efforts made to prepare a similar table in Fig. D.1 in Mr. Marsden's contribution.

Strength and buckling characteristics of the docking girder is mentioned and it is fully appreciated that firm and clear docking conditions must be issued in the loading booklet. The tendency is for the builders to calculate exactly this condition and only provide scantlings accordingly. If, therefore, a different loading condition is used when docking, buckling damages in way of longitudinal bulkhead and girder are indeed likely to occur.

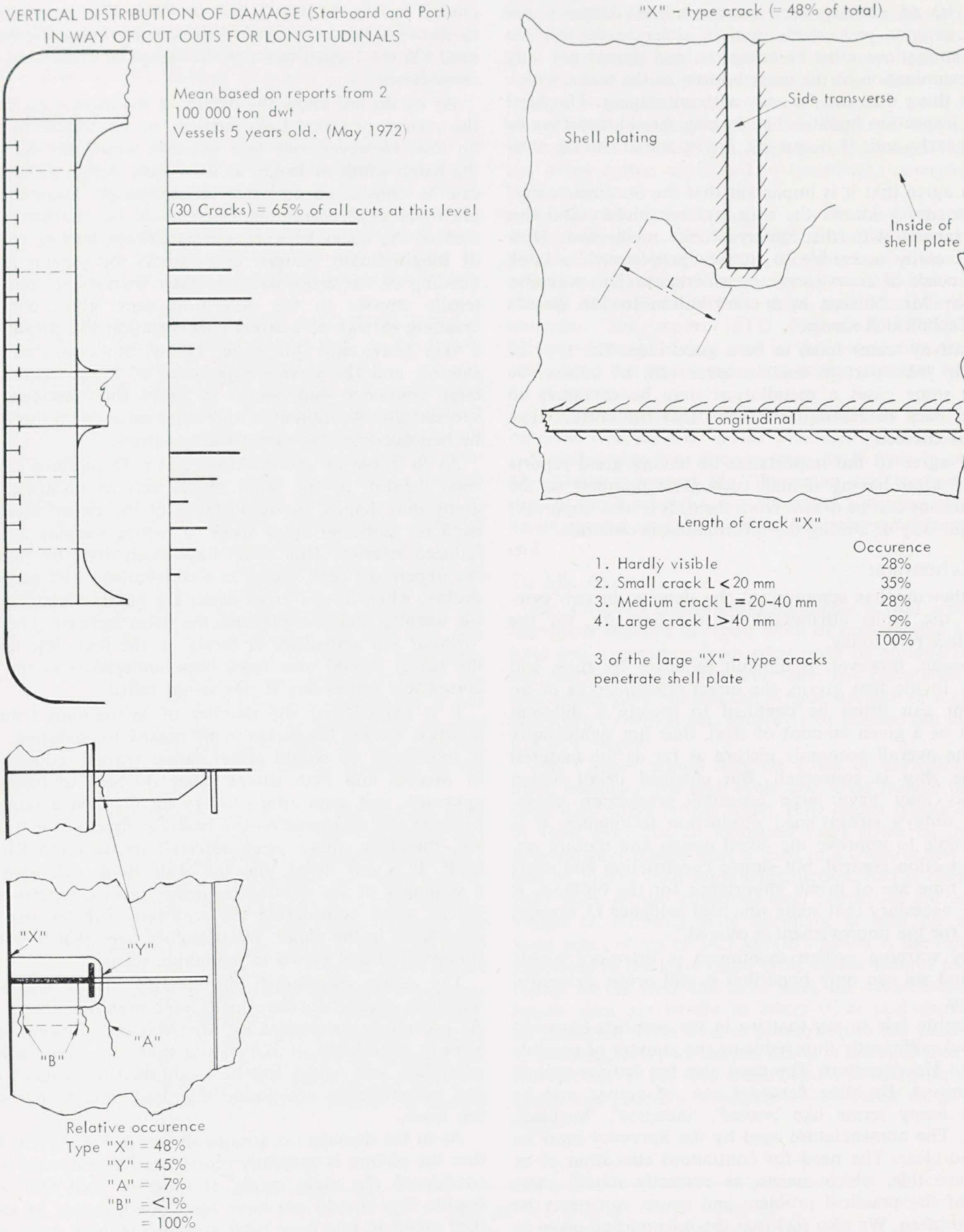

VERTICAL DISTRIBUTION OF DAMAGE (Starboard and Port)
IN WAY OF CUT OUTS FOR LONGITUDINALS
Mean based on reports from 2
100 000 ton dwt
Vessels 5 years old. (May 1972)
(30 Cracks) = 65% of all cuts at this level
"X"
"Y"
"A"
"B"
Relative occurence
Type "X" = 48%
"Y" = 45%
"A" = 7%
"B" = <1%
= 100%
"X" - type crack (= 48% of total)
Side transverse
Shell plating
Inside of shell plate
L
Longitudinal
Length of crack "X"
Occurence
1. Hardly visible 28%
2. Small crack L < 20 mm 35%
3. Medium crack L = 20-40 mm 28%
4. Large crack L > 40 mm 9%
100%
3 of the large "X" - type cracks penetrate shell plate

FIG. D.5

To Mr. Flensburg

Mr. Flensburg takes up the important point of how the large ships described in the paper are to be surveyed in the future. It is, of course, very essential that damages are discovered as soon as possible, and in order to do this the internal examinations must be complete, and should not only cover the examination of the inner bottom of the tanks, which is the only thing that can be seen without staging. The need for proper inspection facilities like staging should therefore be considered early and, if necessary, incorporated during new-building.

We both agree that it is important that the Surveyor carrying out the survey knows the ship and her history and this can be arranged with the Survey Books mentioned. How official and easily accessible to outside people such a book should be, needs of course some consideration. This was also suggested by Mr. Nilsson in a contribution to Mr. Boyd's paper on Technical Records.

Special survey teams seem to be a good idea. The type of specialists to take part in such a team can, of course, be argued. In some cases a metallurgist may be necessary to ensure feed back to Headquarters and that the correct type of repairs is effected.

We fully agree to the importance of having good reports (particularly after having sighted such great number) so the right conclusions can be drawn from them. It is also important that the right way of storing the information is obtained.

To Mr. Mathewson

Mr. Mathewson has summarized the damage in two categories and the faults attributable to the first are, for the reasons stated, rare today.

Detail design, however, is difficult to cover by rules and regulations. In the first group, the direct consequences of an improvement can often be confined to merely a different distribution of a given amount of steel, thus not significantly changing the overall economic picture as far as the material part of the ship is concerned. But changed detail design requirements may have large economic-production consequences in today's stream-lined production techniques. It is always possible to improve the detail design and require improved production control, but simple construction and short production time are of prime importance for the builders. It is therefore necessary that some practical evidence to support the request for the improvement is offered.

The early warning system mentioned is therefore highly necessary and we can only hope that it will prove successful and effective.

It is probably fair to say that we in the outports have not reported back sufficiently thus reducing the amount of possible feed back to Headquarters. The need also for distinct reporting was stressed. Buckling damages can, of course, not be reported in many terms like 'waved', 'indented', 'buckled', 'set in', etc. The nomenclature used by the Surveyor must be uniform and clear. The need for continuous education of us all to achieve this, which means, as correctly stated, some awareness of the practical problem and cause, can never be repeated too often. We also feel that the information given to Headquarters has not, to a fair extent, been returned as summarized guidance. It was a great improvement when the Society issued an internal pamphlet on defects and failures and with the proposed coordination of effort to analyze the cause of the damages it will be even better.

To Mr. Buckle

We do not exactly agree with Mr. Buckle when he compared Sketch 1 and the 'serious and inexplicable failure' included in Mr. Murray's talk in 1964. The latter case refers to the remaining strength of the connection vertical web side shell but the former more to the design of cross-tries and their connection.

As we do not know the details of the mentioned damage to the corners of Great Lake carriers, we are unable to comment on this. However, our first reaction would not be to blame the hatch width or length as such basic design problems often can be considered and duly compensated. Secondary effects are more easily forgotten. Such could be increased compression of the decks between the hatchways leading to buckling of longitudinally framed cross decks, or torsion leading to bending of the cross decks in their own plane, causing high tensile stresses in the outermost deck fibres consequently cracking in way of a stress concentration like a butt between a very heavy and thin plate. Today, however, they are considered, and the service experience of the extreme case, the large container ship, seems to prove that this can be done successfully. As intimated, this experience could therefore also be beneficial for the Great Lake carriers.

As to Table IV the thickness and ε/D columns could have been deleted, as the main object was to illustrate, without going into details, the importance of the closed area and the need for sufficient cross decks to reduce warping and torsion induced stresses. This could have been done by referring to the uppermost deck, which in a conventional dry cargo shelter decker, where broad cross decks are fitted, effectively reduces the warping and thus prevents the stress increase. The wording 'without any crossdeck or struts' in the text (line five above the table) should also have been underlined as the table is completely misleading if this is not noted.

It is agreed that the number of instructions from Headquarters causes headaches with regard to updating, but this is something we would prefer rather than a reduced amount of Memos and Plan letters. They do help to form a basic approach and soon almost every member on a large ship is assessed and approved on the basis of direct calculation. They are, therefore, more often referred to than the Rule Book itself. It is our belief that the Rule Book will soon be just a summary of the existing technical memos, reports and plan letters, when considering the scantlings for the size of ship considered in the paper. We therefore hope that they are soon summarized and edited in a suitable form.

The causes mentioned for damages in the region of the waterline other than wave loads have been noted with interest. As previously mentioned by Mr. Marsden docking loads are already considered. It is believed that soon some calculation procedure and model will be established to evaluate suitably and economically acceptable scantlings due to harbour and tug loads.

As to the damage occurrence shown in Fig. 32 it is believed that the picture is generally representative and wave loads are considered the main cause. It must be said that although double lugs should not have been fitted, except as indicated, they might in fact have been arranged without being reported thus improving the structural capacity in the lower parts.

Regarding Fig. 37, it is agreed that some printing errors unfortunately have occurred and this is therefore shown corrected in an errata sheet. The particular reference to stem line intended to be marked 'A' is correct.

It was interesting to note the high impact loads noted by others and that they seem to correspond with our figures. Our calculated collapse vertical loads on forecastles are also much smaller.

The technical data collection has certainly been painstaking. We do not believe this has sorted itself out with the new computer system but this subject is worth a paper of itself.

To Mr. Thomsson

Mr. Thomsson confirms our experience, indicating it is necessary to be able to practically prove that knowledge available at headquarters is also 'decentralized' to the local offices, within obvious limits. The increased facilities available will also act as a challenge thus indirectly putting increased pressure on the outport staff to demonstrate and increase its technical ability, which can only be to the good for the Society as a whole.

The probabilistic demand—probability concept was included to stress that this is what we have to live with in the future and that safety factors are of a statistical nature.

The practical way to improve the situation is to reduce the overlapping area by concentrating the capability curve against higher (load) T-values and reducing the spread at the bottom of the curve. This can be done by careful design and by controlled good workmanship. Some items of particular interest for the outdoor Surveyors and which must be included in these types of curves are corrosion, deformation, welding effects, material quality and workmanship in general. These uncertainties must be evaluated and given figures in order to understand the overall picture. A good base is needed regarding the relative importance of the parameters involved if we are to be able to devote our resources in the best way. We could, for instance, argue whether it is justified to double our efforts on the plan approval side compared with the outdoor or *vice versa.* Sufficient statistical knowledge is not available to answer such a basic question firmly, but we feel inclined to lean towards the first alternative. In fact very few damages can be clearly attributed to lack of attention by the outdoor staff.

We know of some odd cases where poor workmanship have led to serious consequences but these are the exceptions and only confirm the inefficiency or lack of the yard's own quality control department. This latter department we must assume exists and its function should not be taken over by the Society.

Regarding full scale test we have gradually realized the complications involved and at present, in fact, probably have to drop the idea. During the discussion various contributors have stressed the possibility of calculating the stress concentration factor only and just compare these for different designs. This would probably give a sufficient comparative picture regarding the fatigue properties of the different designs, but knowledge of the load spectrum is necessary as, for instance, the scantling and arrangement requirements differ in tension compared with compression.

To Mr. Merrett

Mr. Merrett was slightly doubtful regarding the conclusions made by us from Table IX. It is probably correct to say that we, in 1967, did not use much computer analysis when originally approving plans. Many of the large builders, however, had done such calculations for their own use. The Society did much computer re-calculation work later to confirm if changes in the first approval were necessary. As a result some strengthening of several ships was required. The service time is, no doubt, limited, but the type of damages considered in the paper (often attributed to insufficient strength) appeared very quickly.

As Mr. Merrett, during his stay in the Gothenburg office, was involved in the scanning of the damage information obtained from Headquarters, he also knows about the work going on regarding damages on all vessels, not only the LR classed large Swedish built ships, and was interested in the outcome. The report (STU Report 70-1272/U 981) has recently been published and in this connection the following table from the report regarding tanker damages will probably be of interest.

The investigation includes only damages which have been reported two years or earlier after the building year.

Detail design has already been dealt with in our reply to Mr. Mathewson and Mr. Thomsson and we certainly agree that a detail repeated one thousand times in one large ship needs careful study as well as vibration problems at the aft end.

To Mr. Capper

Mr. Capper's contribution highlights a vital problem. Most Surveyors engaged in repair work of tankers, like Mr. Capper, have had experience from what must be considered as cracking due to fatigue where corrosion has contributed. A corrosive atmosphere reduces the fatigue strength of a construction considerably which Mr. Murray also pointed out in a previous L.R.S.A. paper.

Mr. Capper argues that the effect of corrosion control is more beneficial for high cycle low stress fatigue than for low cycle high stress fatigue when using higher tensile steel instead of mild steel due to increased yield stress of the material. When higher tensile steel is used in a construction the stresses will be higher than same construction, had it been built with mild steel, as the improved steel properties are used to save weight by reducing plate thickness, at least for steel with a yield point of up to 34,5 kg/cm^2, which is the rule limitation expressed in the k-formula. With similar fatigue properties for higher tensile steel and mild steel, the construction in higher tensile steel can hardly be better if, as said above, we allow an increased stress level in proportion to the yield point.

Unfortunately, we do not know of detailed and representative SN curves for ship constructions in corrosive atmosphere. Until these become available it is difficult to give a precise reply.

	No. of ships	No. of damages	No. of damages/ships
Ships built before 1968	18	481	26·7
Ships built 1968 and later	13	172	13·2

To Mr. Smith

We are in full agreement with Mr. Smith. Approved standard tolerances should be set up. However, we do not share the often expressed opinion that variation of such tolerances can be accepted between different shipyards. Variation between shipyards will exist, but they must be confined to variations necessary due to the building techniques used. We see it as a desirable task to aim for such instructions. Today we have neither time nor money to have the Surveyors educated 'the long way', i.e. to find out by practical experience what the acceptable standards are. But an approved standard system calls for a dialogue between the one site Surveyor and Headquarters in order to have new building methods included in the standards.

Apart from these tolerance requirements which have a clearly presumptive character, the Surveyor must know the influence of the defects found, i.e. the maximum permissible flaws must be specified with a background of fracture mechanics and position in defined quality zones.

To Mr. Hinson

We have noted with interest Mr. Hinson's remarks indicating why a higher frequence of bow damages could be expected with a turbine installation than with a diesel installation. It is agreed that, apart from bow form, speed has a bearing influence on bow damages. As far as aft end vibrations are concerned we believe, however, that a diesel engine installation is likely to cause more trouble than a turbine. Ship's form, number of propeller blades are, of course, other well known factors on aft end vibrations.

Trade, operation and handling are basic considerations when estimating a long term probability curve. It is therefore clear that handling must have influenced the damage pattern.

Printed by Lloyd's Register of Shipping at Garrett House, Manor Royal, Crawley, Sussex, RH10 2QN, England

Lloyd's Register Technical Association

PUBLIC RELATIONS

R. A. Daniel

Paper No. 2. Session 1972-73

Hon. Sec. C. Cummins
71, Fenchurch Street, London, EC3M 4BS

PUBLIC RELATIONS

by R. A. DANIEL

INTRODUCTION

Public relations is "the deliberate, planned and sustained effort to establish and maintain mutual understanding between an organisation and its publics".

Such is the definition devised by the Institute of Public Relations to describe an activity which often seems to lie within blurred limits, embodies a variety of skills, is largely inspired by a blend of instinct and experience and is seldom totally predictable as to its results.

If that sounds too imprecise, let it be remembered that public relations is about communicating with people—and people come in all types and creeds and colours, nurturing all manner of beliefs, harbouring an infinite variety of prejudices and producing an indeterminate number of responses. The public relations practitioner, therefore, always has to think in these "human" terms. That is not to say that the definition is invalid. Rather is it a description of an ideal which is more easily stated than achieved. Nevertheless, it is an ideal which can be attained, given the right attitudes and motivations.

Public relations, then, is not just filling journalists with food and drink in the hope that they will publish the information provided to them. It is a serious and calculated attempt, using a considerable range of methods and media, to establish a rapport with different kinds of people and it involves an attitude of mind which, for the fortunate, is instinctive and for the rest must be cultivated.

Some of the basic facts about public relations which are generally applicable to all sorts of businesses and organisations are set out in the first part of the paper. The second part examines what is or could be done in the way of public relations activity within Lloyd's Register of Shipping.

PART I

SOME BASIC FACTS ABOUT P.R.

Public relations is about communicating with people, so it may be helpful to begin by considering briefly a few points about communication.

In the first place, communication is not a one-way process. To be really effective and useful it must involve reaction and response. There should be a dialogue; and there should be, on both sides of that dialogue, the possibility of ideas being at least modified as a result of the exchange.

Even a dialogue can fail, however, if there is no common language. If two people are talking, but neither understands how the other is thinking, how his mind works, the exchange of ideas is seriously impeded, perhaps made quite impossible. Scientists sometimes find it difficult to communicate with artists, say, because their intellectual training and experience are far apart. Even scientists of different disciplines may have difficulty in fully comprehending one another.

But the successful conveying of a message is not always just a matter of language, of people being on the same "wavelength". Understanding may depend on many other factors. Suspicion or dislike of a speaker, for example, will set up blocks of prejudice in an audience which may prevent his message penetrating, or may result in it being "translated" into something that was never intended, whereas a popular personality is likely to find his listeners eager and favourably responsive. The mood of an audience, too, can affect its capacity to respond; and words in themselves, even quite simple, ordinary words, can sometimes bear totally unsuspected connotations for certain individuals or groups. To complicate things still further, the actual method of conveying a message may be significant in itself and may affect an audience's reaction to the message. Consider what disparate effects might be produced by delivering the same speech in the manner of a revolutionary firebrand and the local vicar.

Despite the difficulties, however, communication is a vitally important process in society. One of the most compelling reasons for conscientious communicating was given in the 1971 Viscount Nuffield Memorial Paper to the Institution of Production Engineers by Wilfred Howard. "Rumour", he said, "is the cancer of communication: it takes over when the healthy organs of information are breaking down. The only way to counter rumour is to ensure the continuous flow of genuine information".

It must, of course, be "genuine information". So long as information is fair and accurate there is hope for the communicator and his message. But let him once lose his credibility and the barriers of distrust will be raised against him and he will be fortunate if he does not have a long and hard fight to break them down again.

PUBLIC RELATIONS AND MANAGEMENT

Most large concerns could identify several categories of people with whom it is in their interests to communicate regularly. These categories could include:—

- Customers.
- Potential customers, whose interest and goodwill go far to guarantee the future.
- Suppliers.
- The general public.
- Opinion forming and influential groups, like politicians, local government, schools and colleges, learned and professional institutions.

Many people would add to that list another group—employees—but it is omitted for the moment, though it shall be returned to later.

In many modern, large concerns public relations (and publicity) is recognised as contributing to the success of the business no less than the technical, commercial and financial functions; so the process of communicating systematically

with various target groups has been, for some years past, a specialised one. But there is one respect in which the public relations function differs from all others in an organisation. It is closer to central management.

Most management structures involve chains of command with fairly well defined levels of authority. Policy is decided and controlled at the top and the day-by-day conduct of business is delegated progressively downwards. The result is usually something like a family tree. But, whereas the head of a commercial or technical department is mainly interested in his part of the business, the public relations officer must be concerned with all sides—though not, of course, with any authority over them. The ultimate responsibility for interpreting an organisation to its publics really lies with the head of that organisation, who is the only person able to take an overall view of the whole and having the authority to express that view. In practice, of course, he generally delegates the exercise of the function to a public relations officer. For that reason, public relations staff are in close and direct contact with the head of the firm and are kept constantly informed of the firm's policies and aims. This is accepted as fundamental to the practice of public relations, for only in this way can they properly discharge their executive function to interpret the firm to its publics. Yet they also have an advisory function, which is in some respects the more important one, although in so many organisations it is not recognised.

The advisory function of public relations appears in various ways:—

1. Ensuring that management is aware of the attitudes of the people with whom the organisation is concerned. Management uses this information in formulating its policy. The public relations officer has no hand in making policy, but he supplies some of the bricks of which policy is built.
2. Helping the head of an organisation to explain it to the public. The public relations staff should be able to advise on how and when to make statements of policy, suggesting the treatments that will be most suitable to the different sections of the public. They will deal with speeches, Press conferences, official visits, etc., and they will watch for possibilities of misrepresentation and confusion and try to avoid them.
3. Following on from 2, the advisory function is extended to nearly all levels in the organisation. Advice on communication is often needed not only at the top. It is to the advantage of an organisation if a sound "public relations" outlook can be created, especially among employees who are in any way concerned with preparing information for public consumption.

MEANS AND MEDIA

The executive functions of a public relations department are exercised in many ways, but especially in the use of the media.

The Press

Of all the media, the Press is undoubtedly the most easily accessible (except in certain countries) and press relations is generally recognised as being the cornerstone of public relations activity.

A Press officer, of course, is concerned with supplying advice or background material to journalists and providing editorial matter in the form of feature articles or news releases. He must understand the needs of the Press and strive always to satisfy them. A Press service is a means of giving out information, not of concealing it; it is also a channel between the Press and the policy makers and the various departmental heads. Any management which thinks that the purpose of Press relations is to defend an organisation from journalistic inquisitiveness—and there are still some such managements, even in this media-conscious age—has completely misunderstood the basic principles and is also denying itself the aid and support of a very influential body.

The people responsible for running a Press service must be able to inspire confidence. They must build a reputation for reliability so that editors and correspondents may turn to them for friendly and trustworthy guidance.

A Press officer is always somewhat in the position of serving two masters. He must at all costs retain the trust of the Press and he may sometimes find himself having to support and defend his journalist friends against his own management. But he must at the same time be unswervingly loyal to his employers and never forget that his *raison d'être* is to serve their best interests with all the skill he possesses. Therefore, he must win the confidence of his employers also and try to make them understand his intermediary position.

Advertising

Another way in which the Press is important is as an advertising medium. Advertising is generally directed to commercial and profitable ends, although it can have its uses as an instrument in public relations and from time to time one sees advertising space bought in order to publish the opinions or promote the interests of a particular social or political or economic group. However, the Author does not consider that, generally speaking, advertising is a tool of first importance in public relations.

Industrial literature

Something which is of much greater significance is the huge volume of published material that is produced by industry itself. Industrial literature comes in several forms:—

- Brochures and leaflets.
- Technical papers.
- Standard reference material.
- Annual reports.
- House magazines (external and internal).
- Educational material, etc.

Over recent years more and more companies have been discovering the advantages of publishing periodicals designed specifically for carefully defined readerships. Some large firms publish several different journals, each aimed at a separate public. The British Association of Industrial Editors now has a membership of more than 1,100 men and women who between them edit publications with a combined circulation at each issue of over 23 million copies, which is far more than all the national daily newspapers. Many of these publications reveal a level of professional expertise which can hardly be bettered.

Literature, in fact, is a most valuable tool of the public relations practitioner. It cannot, of course, stand alone and must always form part of a more comprehensive scheme, yet it is probably true to say that literature, in some form, is an essential element in any public relations programme.

As with everything else in public relations, the production of literature should be deliberate and calculated. It is a com-

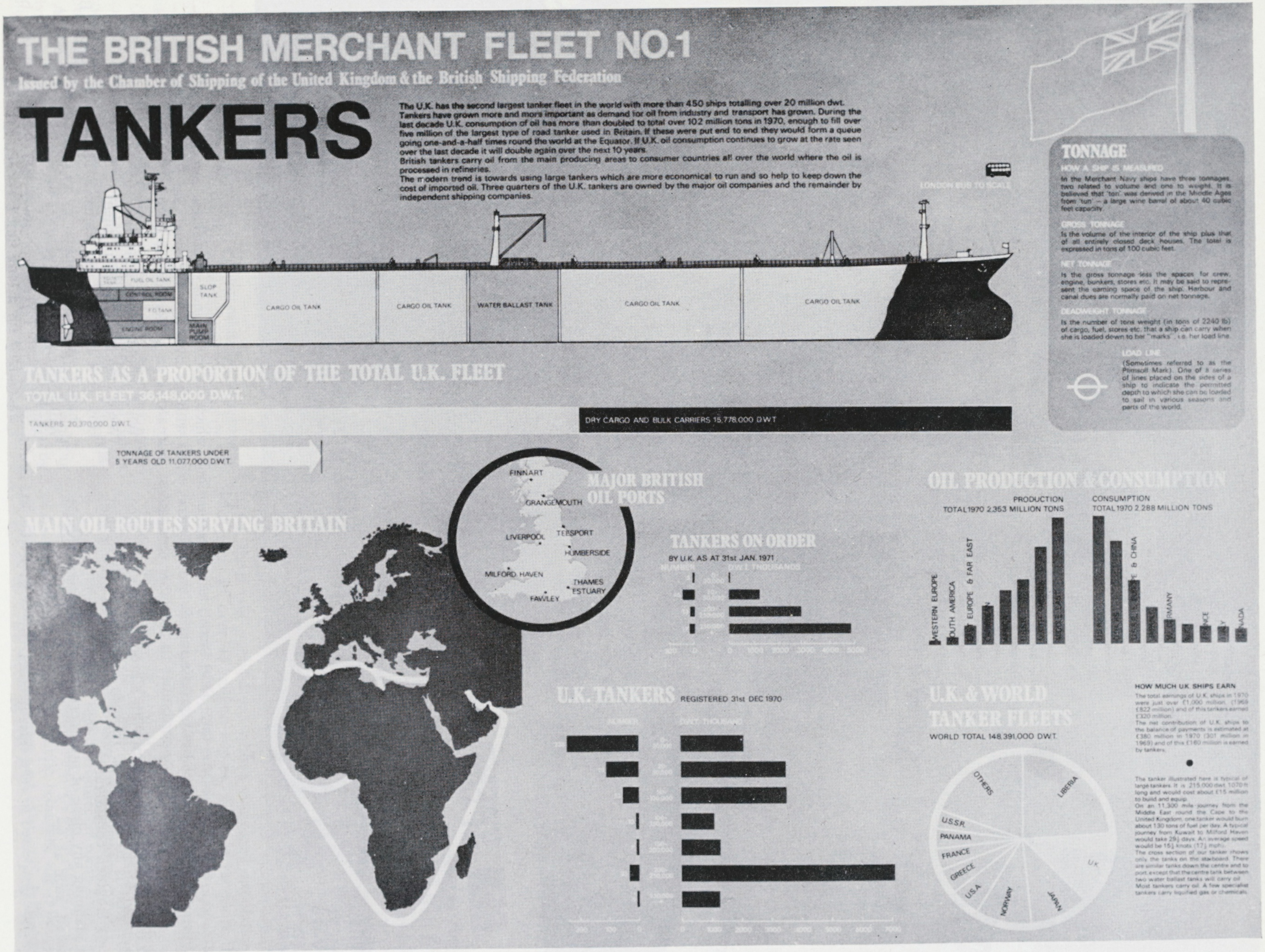
FIG. 1

A handful of the total 1800 British house publications, which serve all kinds of business and industry. The public relations practitioner is not only concerned with his own house journal, but is watchful for opportunities to use other companies' journals as an outlet for his material.

mon mistake to rush into print with a brochure, say, and then decide who is to receive it. In such cases the odds against success lengthen considerably.

In planning any piece of print certain basic questions should be asked, such as:—

Who is expected to read this?
What should people learn from it?
What action is desired of them?
How is it to reach the readers? Through the mail? By hand? At a shop counter or an exhibition?
Will foreign language versions be required?
Will frequent revisions be necessary or will the text be unchanged for a long time?



THE BRITISH MERCHANT FLEET NO.1
Issued by the Chamber of Shipping of the United Kingdom & the British Shipping Federation
TANKERS
The U.K. has the second largest tanker fleet in the world with more than 450 ships totalling over 20 million dwt.
Tankers have grown more and more important as demand for oil from industry and transport has grown. During the last decade U.K. consumption of oil has more than doubled to total over 102 million tons in 1970, enough to fill over five million of the largest type of road tanker used in Britain. If these were put end to end they would form a queue going one-and-a-half times round the world at the Equator. If U.K. oil consumption continues to grow at the rate seen over the last decade it will double again over the next 10 years.
British tankers carry oil from the main producing areas to consumer countries all over the world where the oil is processed in refineries.
The modern trend is towards using large tankers which are more economical to run and so help to keep down the cost of imported oil. Three quarters of the U.K. tankers are owned by the major oil companies and the remainder by independent shipping companies.
FUEL OIL TANK
CONTROL ROOM
ENGINE ROOM
SLOP TANK
MAIN PUMP ROOM
CARGO OIL TANK
CARGO OIL TANK
WATER BALLAST TANK
CARGO OIL TANK
CARGO OIL TANK
LONDON BUS TO SCALE
TONNAGE
HOW A SHIP IS MEASURED
In the Merchant Navy ships have three tonnages, two related to volume and one to weight. It is believed that 'ton' was derived in the Middle Ages from 'tun' – a large wine barrel of about 40 cubic feet capacity.
GROSS TONNAGE
Is the volume of the interior of the ship plus that of all entirely closed deck houses. The total is expressed in tons of 100 cubic feet.
NET TONNAGE
Is the gross tonnage less the spaces for crew, engine, bunkers, stores etc. It may be said to represent the earning space of the ship. Harbour and canal dues are normally paid on net tonnage.
DEADWEIGHT TONNAGE
Is the number of tons weight (in tons of 2240 lb) of cargo, fuel, stores etc. that a ship can carry when she is loaded down to her "marks", i.e. her load line.
LOAD LINE
(Sometimes referred to as the Plimsoll Mark). One of a series of lines placed on the sides of a ship to indicate the permitted depth to which she can be loaded to sail in various seasons and parts of the world.
TANKERS AS A PROPORTION OF THE TOTAL U.K. FLEET
TOTAL U.K. FLEET 36,148,000 D.W.T.
TANKERS 20,370,000 D.W.T.
DRY CARGO AND BULK CARRIERS 15,778,000 D.W.T.
TONNAGE OF TANKERS UNDER 5 YEARS OLD 11,077,000 D.W.T.
MAIN OIL ROUTES SERVING BRITAIN
MAJOR BRITISH OIL PORTS
FINNART
GRANGEMOUTH
LIVERPOOL
TEESPORT
HUMBERSIDE
MILFORD HAVEN
THAMES ESTUARY
FAWLEY
TANKERS ON ORDER
BY U.K. AS AT 31st JAN. 1971
U.K. TANKERS
REGISTERED 31st DEC 1970
OIL PRODUCTION & CONSUMPTION
PRODUCTION
TOTAL 1970 2,353 MILLION TONS
CONSUMPTION
TOTAL 1970 2,288 MILLION TONS
WESTERN EUROPE
SOUTH AMERICA
EAST EUROPE & FAR EAST
U.K. & WORLD TANKER FLEETS
WORLD TOTAL 148,391,000 DWT.
OTHERS
LIBERIA
U.S.S.R.
PANAMA
FRANCE
GREECE
U.S.A.
NORWAY
JAPAN
U.K.
HOW MUCH U.K. SHIPS EARN
The total earnings of U.K. ships in 1970 were just over £1,000 million. (1969 £822 million) and of this tankers earned £320 million.
The net contribution of U.K. ships to the balance of payments is estimated at £380 million in 1970 (301 million in 1969) and of this £160 million is earned by tankers.
The tanker illustrated here is typical of large tankers. It is 215,000 dwt. 1070 ft long and would cost about £15 million to build and equip.
On an 11,300 mile journey from the Middle East round the Cape to the United Kingdom, one tanker would burn about 130 tons of fuel per day. A typical journey from Kuwait to Milford Haven would take 29½ days. An average speed would be 15½ knots (17½ mph).
The cross section of our tanker shows only the tanks on the starboard. There are similar tanks down the centre and to port except that the centre tank between two water ballast tanks will carry oil.
Most tankers carry oil. A few specialist tankers carry liquified gas or chemicals.

The answers to such questions will go a long way towards shaping the final result and determining factors such as size and shape, style of writing, cost of production. For instance, a leaflet to be sent out in umpteen thousands through the mail will be small and light in weight; a leaflet for use at point of sale will be cheap and attractive to the eye; if foreign language versions are required, the differing lengths in print of various languages must be allowed for in the design; and if the English text is to be read by foreigners, care should be taken to avoid words which may be unknown or misunderstood or constructions which may be unfamiliar and confusing.

Exhibitions

Exhibitions nowadays are big business. There are numerous firms whose sole, or at any rate main concern is to organise exhibitions and persuade people to support them by taking space. It is evidently a lucrative business, too, since the pressure on available halls and grounds has become enormous and the calendar each year becomes more crowded. From time to time saturation point is reached in one industry or another, exhibitors cry "enough" and one or two exhibitions die for lack of support; but on the whole the exhibition industry has been in a boom state for a long time.

There seem to be three main ways of viewing exhibitions: as selling operations in which the participating firms hope to book substantial orders; as marketing projects to introduce products or services and break new ground; or as purely prestige exercises intended to promote interest and goodwill and "show the flag".

The would-be exhibitor must know exactly why he should take part in a particular event, what he wants to get from it, what he is likely to get from it and whether the probable results justify the cost. Evaluating an exhibition is notoriously difficult—except for those fortunate concerns that can point to bulging order books at the end of it—and very often rather negative considerations like "can we afford not to be there" will have to be taken into account.

Exhibiting is undeniably expensive, so it is all the more important that participation should be most carefully planned and every opportunity taken of profiting from the event by means of receptions or symposia or coincidental tours by senior management, for example.

Films

Film is a medium which has gained ground as a means of promulgating a public relations message. Carefully used it can be an extremely effective medium; but misused it may do more harm than good.

Because film involves high capital outlay, the first essential for anyone contemplating using it is to define very precisely what it is hoped to achieve with the film and at what audience it is aimed. A 30-minute, full colour feature playing on one of the cinema circuits, costing perhaps £40,000 and containing something for everybody may not be such good value as a modest 15-minute film designed specifically for audiences of retailers or bankers or teachers.

Each medium could be the subject of a separate paper and it is not possible here to deal with any at great length. Each has its merits and its demerits, and it should be remembered that not all media are necessarily appropriate for the purposes of all organisations. It is suggested that the cardinal rule is that no medium should be used unless it is suitable and a definite purpose can be achieved by using it. In other words, only make a film if, on careful examination, film is shown to be the best means of achieving a precisely defined aim; and if a parade of girls in hot pants is the surest way to put a message across to the right audience, then the fact must be bravely faced.

CORPORATE IDENTITY

There are other areas, which are often not thought of as having any relevance to public relations but which are, in fact, important.

Paramount among these is design, in all its applications. It is largely through the skilled and calculated use of design that a company creates for itself what is known as a corporate identity, which is not to be confused with image.

A company's image is what the public thinks of that company; so a favourable image is obtained by persuading the public to hold a good opinion of the company. Corporate identity, on the other hand, is that by which the public recognises a company and all its works. This means that everything pertaining to the company is instantly identifiable—its names and trade marks, its letter headings, the livery of its vehicles, its advertisements, the business cards of its executives, the name plates on its office premises, the uniforms of its messengers, etc.

The basis of instant recognizability is good and carefully controlled design.

Simplicity is the key. However many separate items may be involved, however broad the range of kind and scale—from invoice headings to 40 ft. containers perhaps—the design theme must be consistent and compatible throughout. To achieve this ideal calls not only for great skill but very careful planning and control, without which there will surely be trouble. A famous example is that of Coca Cola. The company had lost control of its design policy and had somehow become encumbered with about 130 forms of identification. The consultants called in to sort out the problem isolated four basic elements: the words Coca Cola (as written by the firm's accountant before the turn of the century), the brand name Coke, the colour red and the well-known shape of the bottle. The entire design scheme was rationalised and reconstructed around those four elements.

The identity-forming elements must, of course, be appropriate to the product. Red is obviously right for Coca Cola, and slate blue, say, would certainly not do for that product, which is essentially associated with leisure and enjoyment, whereas it might be very suitable for the cover of a textbook on the law of tort.

A good example of the use of a design policy in building a corporate identity is afforded by British Rail and it is an interesting exercise to study how relatively few basic elements—colours, emblems and typefaces—have been applied with complete consistency in literally hundreds of ways. The whole scheme is set out in a corporate identity manual. Such a manual is essential for any concern which wishes to create a cohesive visual impression. Also, it offers the considerable

FIG. 2

First of a series of wall charts published by the Chamber of Shipping of the United Kingdom and the British Shipping Federation. A number of large companies and industrial information services produce such charts, which are valued for educational purposes at various levels.

Basic Elements

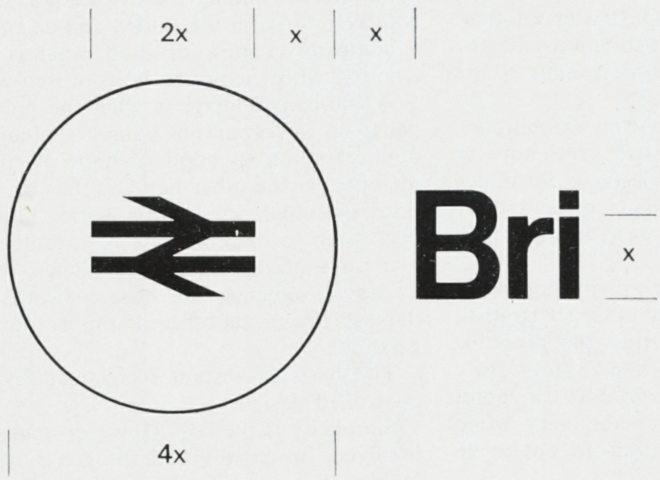
Special logotype for Rail Catering Services

sheet no.	1/48
issued	Jan 1968

Use

This version of the symbol in a circle is for the exclusive use of the Catering Services. It will be used, with or without logotype "British Rail Catering", for all publicity purposes and as directed by the Corporate Identity Steering Committee. The lettering shown and its relationship to the symbol must be accurately adhered to.

Bromide copies of this logotype suitable for reproduction are available from the Chief Publicity Officer BRB



British Rail Catering

British Rail
Catering

FIG. 3

The British Rail Catering House Style Supplement, part of the corporate identity manual of British Rail, specifies in detail how emblems and typefaces are to be used in all catering applications, even down to the insignia on stewards' uniforms. This page from the manual shows how the "double arrow" symbol and the logotype are related.

advantage that it enables local or regional managements to produce their own printed matter, decor, etc., in the certainty that they are conforming to the overall company design scheme.

One must, however, sound the warning that corporate identity should not be an end in itself, but always part of a broader scheme. Indeed, the more cohesive and assertive one's corporate identity is, the more care must one devote to creating a good image (public opinion). It is not difficult to see the dangers of a strong corporate identity associated with a poor image. Therefore it is important that, before embarking on the building of a corporate identity, a management should clearly define its policies and objectives and decide what kind of image it wishes to have.

MARKETING

It is not easy to draw a firm line between public relations devoted to image-building or opinion-forming and public relations directed to marketing, for the two coincide to some extent. A firm's image—i.e. what the public thinks of it—will affect its marketing effectiveness. People will tend not to buy from a company that they do not like for some reason. On the other hand, however well respected a firm may be, it will not sell its product unless the product is seen to be good in its own right. In the marketing context, then, the public relations role is both to create a favourable selling atmosphere by obtaining public interest and approval for the company and to help stimulate buying by ensuring that the public has a good opinion of the product or services offered.

Sir John Hamilton, Director General of the Institute of Marketing, last year wrote: "Marketing is concerned with identifying opportunities in sufficient time to take action on them, and with matching resources to the market for which those resources are most suitable".* This assumes an ability and intention to look perhaps years ahead and spot the place or the public which is not yet, but may be expected to become a market. It also assumes that plans will be laid in good time to meet the demand for goods or services when it arises and that there is not going to be a hectic and undignified scramble rather late in the day. One might go a step farther and say that part of the action to be taken should be a public relations programme designed to create public awareness and goodwill so as to prepare the ground for the selling which is to come.

All too often, what happens is that when the selling operation is about to begin, perhaps has already begun, the public relations people are called in to issue a release and produce a brochure or two. Ideally, the contribution of public relations to marketing should be wider and much earlier. The best means of communication should be found for the particular case; the people who will be selling in the field will need servicing with literature and up-to-date information; and likewise the consumer will look for a good supply of information, perhaps through several media. These things take time and thought and should be taken into account at an early stage rather than be deferred until the last minute.

It is to everybody's best advantage, therefore, if the public relations and marketing staffs collaborate on marketing projects. Public relations staff should always be aware of what the marketing staff is trying to achieve and be able to relate that to the broad scope of company policy. This they manage

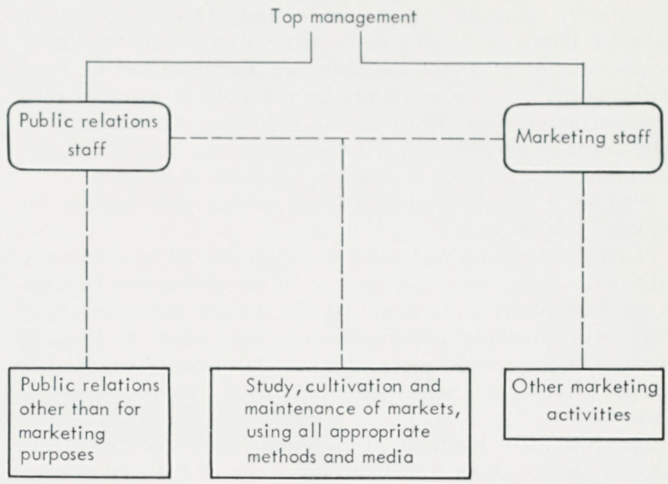


FIG. 4

Relationship between public relations and marketing departments and management.

by direct contact with the marketers and by being kept informed by top management.

It is for the marketing staff to define their objectives and for the public relations staff to decide how they can help the marketers. Together they plan a public relations programme designed to facilitate and promote the marketing operation and the public relations staff see that the programme is carried out. Several methods may be used: Press and literature certainly, and possibly exhibitions, films and TV, lecture tours, facility visits, etc.

In some companies the public relations staff are responsible to the head of marketing. The Author thinks this is not a desirable arrangement, for public relations people are usually concerned with many things besides marketing and, as has already been stated, it is necessary for them to have *direct* access to top management at the highest level possible. (The non-marketing aspects of public relations are divers. They may be concerned with stimulating recruitment; or educating children and students as potential employees or customers; or creating favourable political attitudes; or persuading a community that a firm is well-intentioned and beneficial rather than detrimental.) A diagram of the relationship between public relations staff and marketing staff might look something like Fig. 4. Each department is on a separate line of responsibility, but they collaborate or act independently as appropriate to implement the policy that they receive from management.

EMPLOYEE RELATIONS

There is a particular idea about public relations which has a good deal of currency, namely, that the most important public with which a public relations officer has to deal is a firm's own employees.

That is a very attractive proposition, especially nowadays when industrial relations are so much in mind, but it is a proposition that needs closer examination and some qualification.

Now it is, of course, undeniable that communication is an important factor in the modern human condition and it is regrettable that communication is too often overlooked or

* *Public Relations*, July 1971.

indifferently practised. Some time ago, David Robertson, Head of Publicity for the Industrial Society wrote in *Public Relations*: "It is a sad reflection on the priorities of most British firms that the resources they devote to external relations so far outweigh those provided for communication with their own employees. . . . Either managers believe internal communication is easy or they do not think it matters."

Well, it is not easy and it *does* matter. But equally the manner of it matters.

The first essential is that communication should be systematic. Informal, *ad hoc* methods tend to be unsatisfactory because, in the first place, there is always the danger that pressure of work will preclude communication just when it is really needed. In the second place, the very informality can lead to sloppy presentation with correspondingly reduced effectiveness.

The two main methods of communication are the written and the spoken word. The Industrial Code of Practice attaches the greater importance to the latter and emphasises the role of department or group or section heads in the process. In many organisations, of course, it is not practical to rely solely on oral communication and such devices as house journals, notice boards and letters from management may all find a place in the communications scheme.

The point being made is that communication between management and employees is a matter not only of public relations but also of industrial relations—and that is a job for specialists. Apart from anything else, the whole area of industrial relations has become so complex and hedged round with legislation that it is dangerous for any but trained and experienced people to venture there.

In this context let it be reaffirmed that communication is a two-way process. A few years ago, in a paper to this Association, Mr. E. W. Venner wrote: "Any management is lost if it fails to listen to and understand the mood and opinions of its staff. Likewise a staff which is isolated from its management fails to appreciate the reasons for decisions made by the leadership. It is the duty of the Staff Department to act as a link between those making the decisions and those affected by them, and to report back accurately upon the reactions which are observed".

Nevertheless, the public relations staff can play a part by assisting and advising the industrial relations people on, say, questions of technique and timing, practical matters such as the preparation of handbooks or designing visual aids and perhaps by providing certain services. As it happens the Public Relations Consultants Association this year set up a working party to study the subject of communications in industrial relations; and the PRCA has already had talks with representatives of the Institute of Personnel Management with a view to finding out how public relations consultants could help personnel managers to present managements' views to staff and *vice versa*.

What is of the highest importance is that the public relations and industrial relations staffs should be in close touch with each other so that they never find themselves working at cross purposes. To put it more strongly, there should be definite co-ordination between the external and internal communications programme. If it can possibly be avoided employees should not learn from the Press any important things about their firm which they might properly expect to have been told already. Obviously there will be times when this rule cannot be kept for one reason or another, but at least the principle should be seen to be observed in the main.

PART II

P.R. FOR L.R.

The first part of this paper has indicated some of the basic principles of public relations practice which are applicable to most kinds of business. It will be seen in Part II that those principles are, or could be, applied to Lloyd's Register of Shipping.

WHY PUBLIC RELATIONS?

"What does Lloyd's Register want with public relations? . . . All the people who matter know us already. . . . Lloyd's Register shouldn't demean itself with publicity. . . . Our reputation is our best advertisement."

These and similar sentiments used frequently to be voiced some years ago, when the Society first began explaining itself to the world at large. They are still aired occasionally today, but by and large they have died away as it has come to be realised that age and respectability are no longer sufficiently attractive attributes on their own. There are younger competitors, keen and pushful and able, who are determined to make us fight for our success and our position.

Nor is it any longer true (if it ever was) that "the people who matter know us already". For nowadays there is a whole new lot of "people who matter". In the first place new shipping nations are appearing, changing the market for which the classification societies must compete. Then Governments have become much more involved in maritime affairs, as legislative bodies and as sources of finance, so that armies of politicians and civil servants have started to matter, to say nothing of bankers and financiers.

All these different kinds of people to some extent affect the business of the classification societies. And we have only been talking about the marine area; the pattern is echoed in the non-marine field.

Furthermore, one must look ahead to a time when the viability and status of traditional classification may be very questionable and the societies, if they are to survive at all, will be obliged increasingly to adapt themselves to a different role from the one they have hitherto occupied. Already the beginning of the process can be seen within our own organisation: the gradual move towards consultancy; the diversification into new kinds of work; the introduction of batch and line certification, for instance. Important, too, are the forces of nationalism on the one hand and, on the other, the strengthening (and somewhat paradoxical) tendency for the nations of the world to group themselves into blocs and communities. The classification societies may soon have to effect radical changes in their organisations and present a new face to the world. Presumably the International Association of Classification Societies will gradually lead influential opinion to an appreciation of what the societies will be able to contribute in the future.

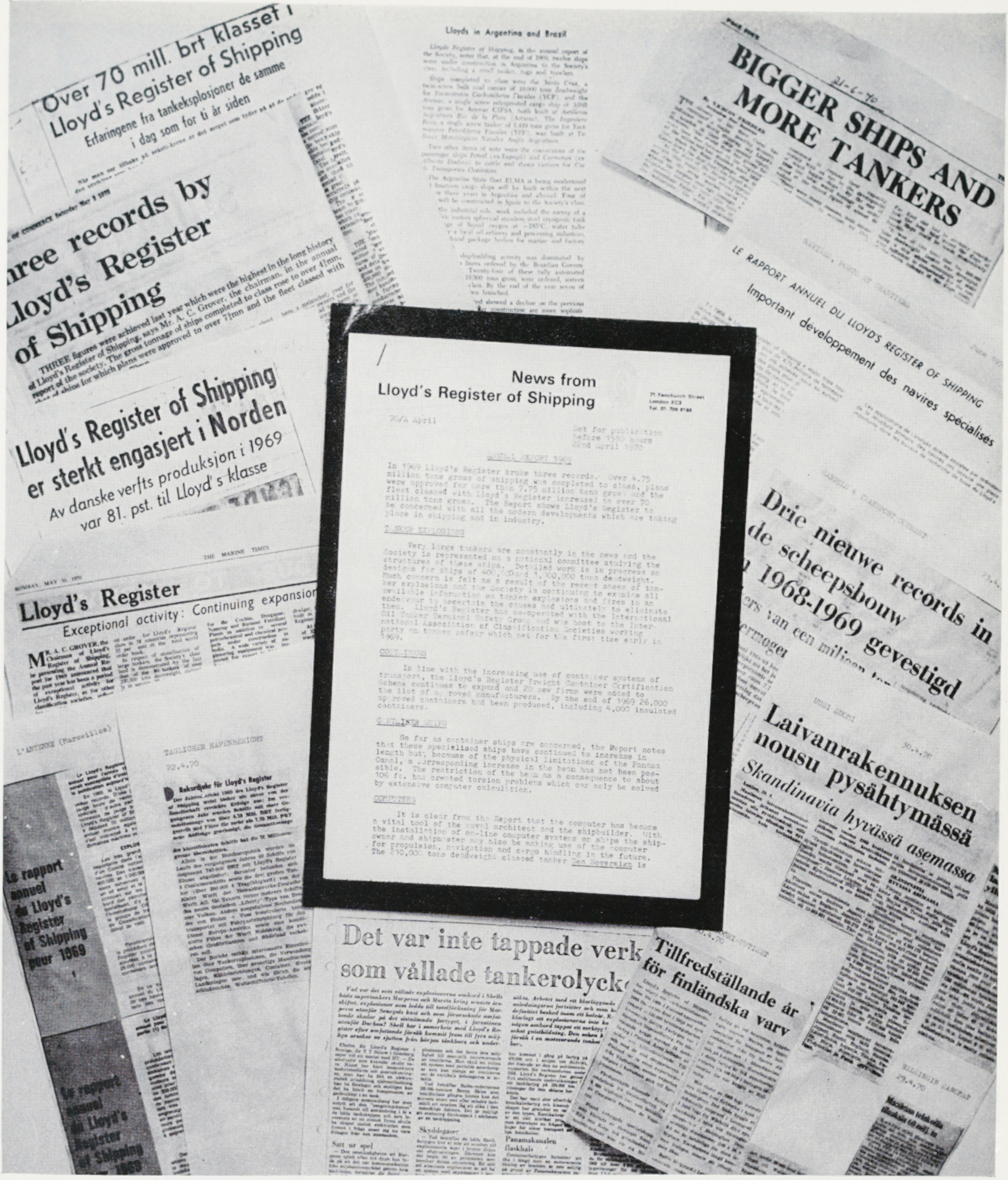


FIG. 5

Lloyd's Register issues news releases at the rate of more than one a week. The releases are published all over the world. This selection of cuttings resulting from a release about the 1969 Annual Report represents papers in 11 countries.

FIG. 6

Feature articles are placed in a wide variety of newspapers and magazines in many countries.

In a changing world and in a climate of vigorous competition, Lloyd's Register needs to publicise itself. It must do so for several reasons: to ensure that the "people who matter" in all the relevant industries, spheres of business and official circles are aware of the wide range of the Society's services and that they are informed of developments and innovations; to promote interest especially in new or undeveloped markets; to counteract the publicity of rival societies and strengthen the morale of its own staff in the field.

The publics whom the Society must inform and influence thus include shipowners, shipbuilders, insurers, financiers, industrialists, politicians, Government ministries and local government authorities, educational institutions and professional bodies.

INFORMATION DEPARTMENT

The Society's publicity is an integral part of the broader scheme of public relations which is carried out on behalf of management by the Information Department.

The Information Department fulfils a twofold function, on the one hand acting as a source of general information about the Society and its work and on the other hand taking positive action to promote knowledge and understanding of the Society.

Providing a general information service involves dealing with a large variety of queries from all kinds of people—journalists or people engaged in research for books or theses, children and teachers, private citizens interested in some particular ship (often one that great-great-grandfather sailed to India in), market researchers or just people with a thirst for general knowledge. Enquiries calling for an expert answer from a particular department are always referred to that department, of course. Within the general service area also the department is required to check and sometimes to write, a variety of texts, perhaps entries in encyclopædias and directories or complete chapters of books.

The major part of the Information Department's work, however, is the more positive, outgoing activity. It may be helpful to outline what that activity entails and to make certain points relevant to the case of Lloyd's Register.

Press relations

As with virtually all public relations work, Press relations are of major importance for Lloyd's Register.

News releases are issued from Head Office at a rate of more than one a week. (The total for the first six months of 1972 was 34.) They are distributed in various ways: by mail, through a wire agency, through overseas outport offices and, in Finland, Greece and Norway, through public relations consultants. An up-to-date mailing list is kept of more than 250 British newspapers and periodicals. The list is sub-divided into 17 "interest groups", so that the most suitable group or combination of groups may be chosen to receive each release direct. The wire service fills in the background of the general Press and especially a broad range of provincial papers.

In addition to news releases, a flow of feature articles is produced. Most of these are commissioned, as a result of either approaching editors or being approached by them. In 1971, for example, 25 separate articles were placed in 17 newspapers or periodicals. Some of these articles are subsequently syndicated through the outports and thus achieve a still wider circulation. Last year's articles included a series of six for a Canadian shipping publication.

Lloyd's Register seldom figures in the big headlines of the daily newspapers. It has little appeal for the popular Press and its interest for the serious business and financial Press is limited by the fact that it is not a commercial, profit-oriented organisation. Its Annual Report and quarterly statistics are normally reported in those papers, and some—the *Financial Times*, for example, and the provincials in industrial and shipbuilding areas—will give a reasonable amount of space to news releases. The story is different with the technical Press, which gives very good coverage to all material released by the Society.

Taking it all in all, Great Britain probably has the best Press in the world. Whilst there are many great, influential and respected papers in other countries, in Britain both the newspapers and the technical Press are of an exceptionally high standard of quality, integrity and sheer professionalism. Thus, in Britain, the Information Department does not have to contend with the custom, so prevalent in some parts of the world, which demands payment for the publication of news releases or urges the buying of advertising space as a kind of bribe to secure the printing of news. This coercion has always been resisted by the Society, because it is considered to be out of keeping with a newspaper's responsibility to serve its readers and because it is thought that an editor should make a professional judgement of news values and select his editorial matter accordingly. It may not be a realistic attitude and perhaps the Society will eventually capitulate, though it it to be hoped that it will not.

As regards the role of outports, it is fully understood that Press relations must always come rather low in a busy Surveyor's list of priorities and that sometimes it is virtually impossible for him to do anything at all. A number of the larger outports, however, do a very creditable job of servicing the Press, using the material that is issued from London Head Office as well as, in some cases, initiating their own local stories. Certainly, outside the U.K. successful Press relations depend entirely on the outport staffs (except where consultants are employed).

One thing which contributed to an improvement in Press relations in a number of countries was the introduction of Press conferences to present the Society's Annual Report, coinciding with the Chairman's conference for the same purpose at Head Office. These conferences have done much to help Surveyors understand the needs of journalists and to make journalists think of the local Lloyd's Register office as a source of reliable information.

Exhibitions

Apart from one or two isolated cases, the serious involvement of Lloyd's Register in the exhibition field began in 1963,

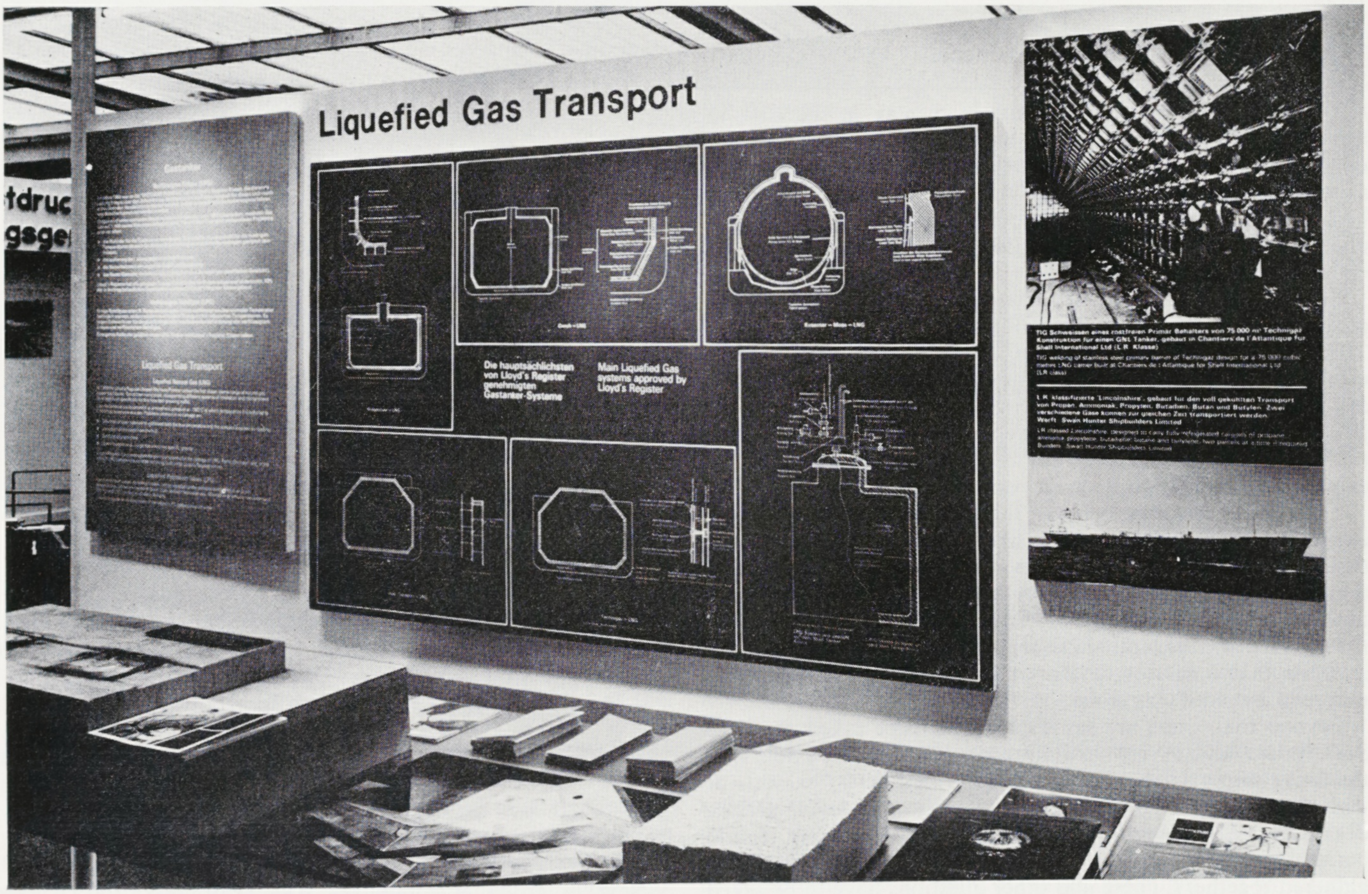


Fig. 7

At exhibitions Lloyd's Register must present technical matter attractively and in easily assimilable form. This panel on liquefied gas transport systems was the main focus of interest on the Society's stand at the Hamburg Schiff und Maschine exhibition in October 1972.

when the Society joined half a dozen other organisations on a group stand under the title "British Shipping Services" at the first Navigare marine exhibition in Helsinki. The table gives the full list of exhibitions in which the Society has taken part in the following nine years.

Year	Title	Venue
1963	Navigare 63	Helsinki
	International Fair	Genoa
1965	International Shipping Exhibition	Oslo
1966	Britain 66	Oslo
1967	International Sea Transport Exhibition	Gothenburg
	Navigare 67	Helsinki
1968	Nor-Shipping	Oslo
	Ships' Gear International	London
	International Container Exhibition	London
1969	International Sea Transport Exhibition	Gothenburg
	Container Exhibition	London
	Container Services Exhibition	Melbourne
1970	Posidonia '70	Athens
	International Trade Fair	Valencia
	Containerisation '70	Munich
1971	Nor-Shipping	Oslo
1972	Posidonia '72	Athens
	Ship and Machinery International	Hamburg

For six years the Society also had a display in the City of London Pavilion, a mobile exhibit designed for use abroad, mainly at British Weeks. From 1965 the Pavilion was exhibited at Amsterdam, Lyons, Milan, Oslo, San Francisco, Stockholm, Tokyo, Toronto and Vancouver and it was seen by an estimated 1,100,000 people. It was used for the last time in 1971.

As has already been stated, evaluating exhibitions is a major problem, especially for organisations such as Lloyd's Register. The kind of people who came to the stand, the sort of questions they asked, the display items that interested them—these are some of the pointers by which one must eventually try to judge whether the exercise has been worthwhile. The one thing that can never be said with any certainty is that any business came to the Society as a direct result of exhibiting.

The Author has long believed that the Society exhibits more effectively at specialised events, like the container exhibitions, than at the general marine shows. In the former one knows that the great majority of people coming into the hall are likely to be interested in what one has to tell them, whereas the visitors at a general show represent such a wide range of interests that one tries to attract several groups at once and may end by satisfying none.

Beyond that, there are some questions to be asked. Will the Society lose face by not exhibiting when competitors do? Will the local outport staff be encouraged if the Society exhibits or will they suffer if it does not? As an international service organisation, is it or is it not fitting that the Society should be seen to support events at which many of our clients are gathered together? These and other questions have to be asked each time participation in an exhibition is considered, for the answers may well differ according to the subject and standing of the exhibition, who else will be taking part, where it takes place and the state of the Society's affairs there. It must also be decided how the event is to be treated—whether as a matter of prestige and flag-showing or as part of a marketing operation.

At the present time the Society's management is mostly not in favour of taking part in exhibitions and certainly there are many cheaper and probably more effective ways of publicising the Society.

Papers and Seminars

One of these ways is the presentation of papers to invited audiences, either as individual offerings or as part of a seminar organised by the Society. (Papers are often read to professional institutions, of course, and are of great value in drawing attention to the technical thought of the Society).

The Society has arranged seminars in the past. In 1967 a two-day programme of lectures was organised at Head Office for a group of non-technical people from senior management level in the shipping industry, with the purpose of helping them to keep up to date with developments in shipbuilding and marine engineering. The method seems to be one which could easily be employed in many other places.

Whether the arrangements consist of a single paper presented at an evening meeting, or a full-day seminar with several papers and a panel to lead discussion, the great advantage is that the organisers are in a position virtually to hand-pick the audience. This degree of control can hardly be achieved in any other way and, barring the hazards of communication mentioned at the beginning of this paper, the method should prove highly effective. It must also represent excellent value for money in terms of *per capita* cost. Nevertheless, as with all public relations activity, this kind of exercise should form part of a cohesive plan.

Publications

The Society's publications fall into two basic groups:—

A. Those which people need and for which they are prepared to pay.

B. Those which may not be essential to the reader, but which it is to the Society's advantage that he should have.

Group A includes the Register Book, the Register of Yachts, the Rules and such things as the List of Type Approved Instruments and Control Equipment; while group B embraces all public relations and "sales" literature.

Group A is outside the scope of this paper.

The group B publications at present include the following titles:—

Lloyd's Register of Shipping: what it is and the work it does.

Marine and Industrial Inspection.

Engineering Inspection for Industry (with five supplements).

Technical Investigation.

Specification Services.

Computer Services.

All these are edited and produced by the Information Department in collaboration with the appropriate technical department(s).

Next in group B comes the Annual Report, *100A1* and *Lloyd's Register World.*

100A1 was written and produced by the Information Department for 14 years, but has now become the responsibility of the Publications Manager.

FIG. 8

Some of the Society's Group B publications. They were all designed by one of the most experienced British typographic designers.

Lloyd's Register World was devised by Information Department at the request of the Management Committee and is intended to reflect the Society's very varied activities all over the world. It is circulated on the same distribution list as the Annual Report and thus reaches a select and high grade readership. It supplements, but in no way replaces the normal programme of Press publicity.

Group B also includes *Yacht Services* and other pamphlets produced by the Yacht Department, the series of Technical Reprints and, finally, a miscellany of booklets and leaflets for special purposes, such as centenary commemorations and exhibitions.

There is in the Society a body of opinion which holds that some of the publications should be abandoned and that one comprehensive volume should be produced at regular intervals which would embrace all manner of articles, news, technical papers and reports, etc. The theory, which has its attractions, is that everybody would get the same package and take from it what suited them and there would be no need for selective distribution.

Unfortunately, there is some doubt that it would work that way. In the first place sheer volume would probably deter readers rather than attract them. Secondly, making the recipient sort out for himself a large amount of material might well produce the exact opposite of the desired effect and, by trying to be all things to all men, the magazine might end by satisfying none. In the third place, it would be uneconomic to print and distribute thousands of copies of what would be quite a weighty publication if each copy were going to be only partly effective.

FIG. 9

Special events call for special literature. These brochures were produced for centenary celebrations in Australia, Denmark, France and Holland.

Major industrial companies do not shrink from publishing a wide range of literature, each item being planned for a particular readership. This brings one back to the principle previously stated, that any piece of literature should be planned on the basis of complete knowledge of what it is intended to achieve, by whom it is to be read, how it is to be distributed, etc.

EDUCATION

The educational field seems to have been sadly neglected by public relations practitioners over the years, although the situation is probably much better now than it was when most readers were at their schools and colleges. Presumably it took people a long time to realise that today's children and students are tomorrow's customers and employees.

Lloyd's Register, like many other concerns, receives requests from school children and their teachers for information. Many companies produce educational material at various levels. One of the most popular types of material is the wall chart. Wall charts need not be restricted to the schoolroom, but they can be designed for use at a more advanced level, such as the training of apprentices.

Career guidance in schools and colleges has always been bad, in Britain at least. It would be interesting to know how many of the present members of Lloyd's Register Technical Association were aware of Lloyd's Register at the time they were leaving school and how many knew anything much about it, other than that it published technical rules, by the time they had finished their apprenticeships or university courses.

It may be argued that a formal effort to give students an understanding of Lloyd's Register and knowledge of its work is unnecessary as they will soon learn about it when they go out into industry. So they will. They will also learn about the other classification societies. The Author believes that the Society should try to ensure that they start their careers with a very good idea of what the Society does, what it stands for and how it works. It is true that, in the last few years, an annual lecture has been given at Newcastle upon Tyne University and doubtless many surveyors have given talks at their local colleges from time to time. However, valuable as those events must have been, they might have been even more effective had they formed part of a deliberate educational programme.

Here, then, is an area in which public relations activity could perform a very worthwhile service for the Society. It would be perfectly feasible to set up a programme, to be continued over a period of years, which would serve the dual purpose of interesting potential recruits and building a good opinion of the Society in those people who will eventually progress to positions of authority in industry and may be instrumental in bringing work to the Society.

MARKETING

As indicated in the first part of this paper, marketing is largely concerned with looking into the future and trying to discern where and when opportunities are going to arise and then planning to take advantage of those opportunities.

For a concern like Lloyd's Register, operating internationally, such forward studies are highly important and more than a little complicated. They must take account of political and economic trends (including the formation of blocs and trading

communities); the use of natural resources and control of the environment insofar as they may affect the development and distribution of industry; and the progress of technology, which will be a major factor in determining the Society's future activity.

Having identified the probable opportunties in a given area, it would be necessary to decide how the Society's reputation should be established or extended and to undertake the appropriate action in readiness for the time when the Society's services would be required. In this respect the local outports would have an important part to play, both in determining the local standing of the Society and in helping to implement a public relations programme to consolidate or improve it.

That is the preparatory aspect of the matter. In the shorter term public relations methods may be used in a promotional way to stimulate immediate interest in, approval of and, hopefully, purchase of services. Once again, Press publicity should be a key instrument, but the armoury may be extended with literature, exhibitions, specially arranged lecture meetings and seminars, films, facility visits—any or all of these in combination.

The important thing is that the likely need for action should be recognised in good time to allow a co-ordinated programme to be worked out.

The possible benefits to be derived from securing the informed approbation of trade delegations should not be overlooked, not only those coming from target areas but also those visiting target areas from elsewhere. The Society has, on occasion, taken steps to ensure that at least the leader of a trade mission knew of the Society's interest in an area and that he understood the nature and scope of the services offered.

EVERYONE IS A P.R.O.

The corporate reputation of Lloyd's Register of Shipping has always been based on integrity and impartiality—on that admirable motto *Sine praejudicio*.

Nowadays, when the tenor of the times allows the consciences of men to yield to expediency, the posture of the honest, independent arbiter is sometimes difficult to maintain. Yet it is most important that the Society should deserve and be seen to deserve that high reputation, for it is a precious asset. Every member of the Society carries it in trust.

At the same time there is no room for "holier than thouness". Reputations are seldom so lustrous that they cannot be improved and polished.

It has to be admitted that one area in which the Society has not publicised itself enough in the past is that of technical research and initiative. The belief that Lloyd's Register is somewhat less forward-looking, rather slower to bring itself up to date even, than certain of its rivals has been too prevalent for too long. It is no answer to say that such a belief is ignorant and ill-informed. That is just the point—it *is* ill-informed.

It is up to every member of the Society to help dispel that ignorance at every opportunity.

Each member of staff is caught up in public relations, not in a formal, full-time way but simply by having to do with the public. Thus, any Surveyor who gives a paper or a lecture, any Surveyor who discusses a problem with a designer or a superintendent, any clerk who deals with an enquiry on the telephone, is involved in an act of public relations in the sense that by his words, his manner and his knowledge he influences the ideas of one or several people about Lloyd's Register. In other words, he does something to the Society's reputation or "image". That is one reason, though not the only one, why management should ensure that staff are well informed about what the Society is doing and where it is going.

The reputation of the Society will not be based solely on its integrity and technical merit either. A general air of efficiency (or lack of it) will play its part. No doubt all staff, on occasion, have been guilty of some sin of omission, some oversight, some careless act. Although such faults cannot be condoned they are at least pardonable, provided they are not characteristic. Again the burden falls mainly on the staff at all levels to ensure that the Society's dealings with the world outside are efficiently conducted; and that, if there are any inherent flaws in the system, their irritant value is minimised as far as the public is concerned.

Outport staffs, especially overseas, bear a particularly heavy responsibility in the public relations area. In the first place, they often enjoy a high status in business and industrial circles and they are looked to as the ambassadors of the Society. Indeed, in some ports, Lloyd's Register *is* the local Surveyor and not the headquarters to which, as ribald rumour has it, he is constrained to refer for instructions.

In the second place, the outport Surveyors act as local Press officers, dealing with queries, acting as a link with Head Office in cases which they have not the resources to handle alone, and issuing the material which they receive from the Information Department, often having to get it translated first. They also have a responsibility to compile and from time to time revise the mailing lists that are used for distribution of the Society's periodicals.

All in all the majority of outports seem to do as good a P.R. job as their conditions allow.

There is, however, one respect in which those in Head Office could wish for some improvement and that is in the feed-back. Unless it is known how effective the P.R. and publicity efforts are, it is impossible to judge how they should be modified. Some outports do very well in this respect, passing back Press clippings, etc., but from others little is ever heard. While it is appreciated that it means writing yet another letter, it would be extremely helpful if a batch of clippings or a brief report or comment could be forwarded once in a while.

That said, the record should be balanced by acknowledging a debt to the outports which respond so magnificently to requests for material for the Annual Report, demands upon their time and energies for translations and the many other ways in which their aid is solicited in conducting the Society's public relations.

CONCLUSION

The principles outlined in the first part of this paper are generally applicable to the case of Lloyd's Register of Shipping.

Public relations can serve the Society in both the long and short term and may be used for building and nurturing a corporate reputation as well as for helping to promote business.

The Society's public relations activity must be based on Head Office, which is the seat of central management and the source of policy; but members of staff everywhere are essential to the successful conduct of that activity. Furthermore, they have their own function as individuals in "winning friends and influencing people".

Printed by Lloyd's Register of Shipping at Garrett House, Manor Royal, Crawley, Sussex, RH10 2QN, England

Lloyd's Register Technical Association

Discussion

on

Mr. R. A. Daniel's Paper

PUBLIC RELATIONS

Paper No. 2. Session 1972-73

FOR PRIVATE CIRCULATION AMONGST THE STAFF ONLY

Hon. Sec. C. Cummins
71, Fenchurch Street, London, EC3M 4BS

Discussion on Mr. R. A. Daniel's Paper

PUBLIC RELATIONS

Mr. R. P. HARRISON

Many of us, especially those who have raised families, are acquainted with the writings of Dr. Spock. His book, dealing with the care of children, when used as a reference for specific individual doubts or crises, is both helpful and calming; yet, if one attempts to plough through it from cover to cover, several sections appear to conflict or contradict, so as to produce some confusion. I believe the same to be true of many works dealing with that baby we sometimes hold, called Public Relations. However, tonight we have listened to a very concise account by Mr. Daniel, which could well have borne the title 'Public Relations made Easy'. I would like to express thanks to him, both for the paper and for the interesting and pertinent film we have just seen.

Public relations appears to have evolved over the last 20 or 30 years as a science, or as a specialised branch of business. It is now interesting to see, examined in detail under this title, the various possibilities and processes for promoting communication and confidence between an organisation and its clients. I do believe, however, that such practices have for centuries been carried out by successful—I would stress 'successful'—enterprises under the less sophisticated names of 'shrewdness' and 'business acumen'. It is, possibly, the disappearance of a host of individual influential proprietors and their replacement by many 'organisation men' in modern competing concerns, which has led to the present clinical appraisals of public relations.

Mr. Daniel's introduction included the definition of public relations attributed to the Institute of Public Relations, and certainly no criticism can be attached to that definition. However, it can be mentioned that the International Public Relations Encyclopaedia contains no fewer than 15 varying definitions of the subject, including one by the successful US publicist Carl Byoir, reading 'Public relations is whatever the individual practitioner thinks it is'. This last definition is somewhat startling, if not facetious, and induces my reaction, based upon some experience overseas, that Mr. Daniel's paper contains much more helpful guidance to those seeking knowledge on the subject.

On the question as to whether or not a rather unusual organisation, such as Lloyd's Register, should be deeply involved in PR work, I venture to say it should be, for the following reasons:—

(1) There has been a drastic reduction in the percentage of the world's ships built to the Society's class over the last quarter of a century, a fact that is too often glossed over by the increase in the world fleet having the effect of enlarging the actual tonnage classed with Lloyd's Register.

(2) Other classification societies are competing for an increasing share of this world fleet. Regrettably, some are using extremely effective PR methods, such as in Scandinavia.

(3) The number of times it is necessary for many of us to explain within the shipping community the exact function of Lloyd's Register of Shipping and the extensive services it offers to that community. The advent of Industrial Services has simply increased the area where such enlightenment can be spread.

(4) In an era of rapid technological developments, the Society is compelled to make it known to clients, and particularly potential clients, that it is keeping abreast of such developments and is, in fact, introducing these innovations into its practices for their ultimate benefit.

A cursory glance at the various reasons advanced for LR's participation in PR activities shows that, basically the Society has something to offer clients and has reasons for doing so. These reasons do, to some degree, highlight Mr. Daniel's assertion that 'it is not easy to draw a firm line between public relations devoted to image-building and opinion-forming, and public relations directed to marketing'. I regret that he continued, 'for the two coincide to some extent'. Although the remainder of this section of his paper then proceeds to elaborate on the separation of these two aspects, it is my belief that all PR work is, fundamentally, undertaken for the express purpose of ultimately improving marketing prospects. It is therefore thought that the Society's external PR planning should be with this ultimate purpose in mind, even though the modes or methods involved will perhaps frequently appear quite divorced from direct selling or advertising. The extent and cost of PR activities needs to be carefully watched. Mr. Daniel may, perhaps, care to remark on the proportion of a budget that can be reasonably devoted to such activities.

The international character of the Society and the considerable proportion of its business and staff abroad merits special attention to the PR requirements of the major areas outside the United Kingdom, where conditions, customs and languages can vary so tremendously. In this connection I would venture one or two observations, questions and suggestions. Mr. Daniel may care to comment on the following:—

> It must be acknowledged that the main flow of material forming the basis of PR activities originates from Headquarters, but, for this material to be effective overseas, it is frequently necessary for it to be coupled with, or compared with items of local interest or background and presented in appropriate language by the outports. Can this procedure be left completely to the people on the spot?
>
> The timing of PR operations is vitally important. I would stress this point, if maximum benefit is to be ensured for the effort and expense involved.
>
> The importance of personal contacts with clients, authorities, Press, etc., overseas cannot be overstressed. Provided such relationships are cordial, they are much more effective than a deluge of printed matter which can be, only too quickly, conveyed to the wastepaper basket unless it is sufficiently eye-catching and interesting to immediately captivate the reader. Here I would repeat an old plea that any publication which the Society considers should be retained for reference by clients, etc., should be printed A4 standard, and not on one of the 30 various sizes which have been used in the past.
>
> Efforts should be made to maintain or establish good relations and understanding with local press officers. Even Napoleon openly admitted he feared the Press more than a thousand bayonets!

It is suggested that resuscitation of the 'News Letter', or 'Maltese Cross' as it was later called, will help to improve internal communications. This publication is particularly missed by both staff and pensioners abroad.

Lastly, I would enquire if a curb should not be placed on the amount of valuable information which is distributed by the Society, free of charge and often without positive returns. It is thought that the function of our PR should be to make it widely known that such information is available and can be obtained—at a reasonable charge.

To conclude, I would thank both the Committee of the Association and particularly the Author for the opportunity provided to learn something of an essential, but rather sharp and expensive tool, public relations; a tool that should be insofar as the Society is concerned, designed for limited output of quality products—as we have seen from the results of the Information Department—but which, like many other sharp tools, if badly handled by the inexperienced or uninformed, the operator may be injured or perhaps the blade blunted.

Mr. H. D. RENGGER

I regret that the Marketing Manager is ill and so is unable to be here tonight for I am sure he would wish to comment on this paper from the marketing viewpoint. On his behalf, therefore, I would reserve his right to add any remarks he may wish to make for inclusion in the written comments. For this reason, and also because I have been unable to study the the paper as fully as I would wish prior to this meeting, I shall keep my contribution very brief and confine it to the two sections of the paper which relate to marketing.

I find it a very interesting account of the public relations scene and would like to add my congratulations to the Author on his paper which may help to dispel some of the mist which tends to surround the scope and value of the work not only of the PRO but also of the somewhat broader sphere of marketing.

I note that in Part 1 (page 7) the writer states: 'In some companies the public relations staff are responsible to the head of marketing. The Author thinks this is not a desirable arrangement, for public relations people are usually concerned with many things besides marketing . . .'. Whilst appreciating his views I hope he will feel it is fair comment to say that marketing people too are concerned with a great many things beyond PR and perhaps on a wider front! This leads to the Author's comments on structure and his suggested layout as given in the diagram. I am not necessarily in disagreement in specific terms but have my own doubts as to the validity of his argument in general application. Marketing is, in essence, a broad strategic, tactical and policy concept applicable to a company's operations as a whole. It should provide the foundation on which the organisation's overall forward policy planning can be based and supply the direction for specific area implementation.

It is in this context I would think that it is essential that publicity and PR operate within the overall marketing sphere and it is for this reason that most large organisations which have their own marketing and PR functions (as opposed to agencies) are structured accordingly. This does not, of course, in any way prevent the independent top access and operation of the general PR function relating to matters outside marketing policy. I would value the Author's further comments for, as I am sure he knows, I too firmly believe that good PR is essential to the success of the overall enterprise and the best possible liaison is a *sine qua non.*

In the light of the foregoing I would like to turn to Part 2 of the paper, pages 14 and 15. Whilst I generally agree with most of the comments, the Author will, perhaps, not be surprised if, having taken a somewhat different view of his earlier priorities, I draw attention to the first two paragraphs as illustrating the broader context of marketing. I also feel it is important to clarify the difference between marketing, PR and selling. If the marketing function is the operation in a strategic, tactical and policy sense of the overall marketing concept this, itself, must relate to the application of marketing thinking to the corporate enterprise as a whole and involve the active recogntion, throughout an organisation, that it exists to seek an end profit by way of client satisfaction. Within this framework 'selling' is, of course, the cutting edge and PR expertise an essential concomitant, but both are operational exercises implementing marketing strategy based on adequate market research and appraisal.

I think, too, we should never forget that whilst, in theory, everyone can and should be both a PR man and a salesman for LR, the front line reality usually lies with our colleagues in the field whose daily round brings confrontation with the market.

In conclusion I would like to pose two questions: (a) many hold the view that, because of the nature and background of the Society's operations, advertising in the usually accepted sense is not applicable. Does the Author agree or does he feel that there is room for development? I think I should add that whilst I do not envisage giant posters 'LR Ships stay Stronger Longer' or 'Twice the Ship on LR Class', neither do I include matter which tends mainly to reach only those sections of the technical world who are already aware to a greater or lesser degree what LR is and does. (b) Given a free hand and adequate budget what 'attack line' would he like to make his first priority?

Mr. L. BECKWITH

There is no doubt that we live in an era when public relations is considered to be the 'in' thing. Unfortunately, in some cases having the right image is thought to be more important than giving a service although, of course, the one should follow the other.

At the beginning of this century the Lloyd's Register Surveyor was his own public relations officer as well as being the Society's ambassador at large. Agreed, things were not so complicated in those days, the Rules did not change at frequent intervals as they do now, and the Society was not involved in so many fields as it is today. Consequently the Surveyor was able to present the image of 'Mr. Lloyd', knew what was going on in Lloyd's Register, and was able to advise his clients on the spot without needing to refer too often to London.

Mr. Daniel asks the question 'why public relations?'; gives some of the sentiments frequently voiced and says that by and large they have died away. However, I heard only recently what might be called a well established member of the staff stating: 'Things are changing far too quickly in the Society—it is not like it used to be.' Of course it is not like it used to be and it will never be the same again. I think Mr. Daniel has probably done the Society a great service in producing this paper on public relations, because by drawing attention to the

problems involved he may have stirred some people into asking themselves how they can project the Society's image in present day conditions.

There are two main points on which I would like to comment. These are not connected with the broader issues, but rather with internal organisation, and concern communications education. I am sure we would all fully agree with Mr. Howard's statement that rumour is the cancer of communication. We are all fully aware of the grapevine which exists in all large organisations, and we all know the people who have been told that they are being transferred or have been promoted, only to find that everyone else knew about it before they did. This is only one area of communication, but a very important one which deals with the human aspect of the problem. The point I am really making here is that before we can satisfactorily communicate outside the organisation we must be able to communicate adequately among ourselves. I think communications have improved within LR recently, but there is still a lot to be done. We are growing quickly and new departments are springing up dealing with new subjects. It is impossible for us to make ourselves familiar with the nut and bolt details of these new subjects, but we should at least be in a position to know *what* the Society is doing and *where* it is being done.

Some 15 years ago it would have been possible to attend one of these meetings and to know everyone by name and department and have a fair idea of what job of work he was engaged upon. This certainly is not the case today. Look around you, at the man next to you or in front of you; do you know where he fits in this organisation and what he does? There is a good chance that you do not. I know that when I come to these meetings or when I walk through the various buildings I pass people I have never seen before, they could in fact have come in straight from the street and not be a member of LR staff as far as I am concerned. Obviously, with a large number of people in the organisation, it is difficult for us to know every person, but I feel that if we are to be able to communicate fully with clients we must be made aware of what the Society is doing, and at the same time familiarise ourselves with the work of various departments. In this respect, Mr. President, I feel that this Association could help by arranging for more informal meetings where people could find out what is going on in various departments.

In order to communicate we must be educated. Whilst Mr. Daniel mentions the education of tomorrow's customers and employees I would like to relate this to the present staff. Our training establishment has made an excellent start in this respect, but it is not possible to educate all technical and non-technical staff in this way. We had an excellent paper presented to this Association a year or two ago on training and information and it is this latter item which causes the greatest problem. I agree with Mr. Daniel, we have got to be careful of the type of literature that we publish, but I am sure that our colleagues in outports will agree that it is important that they be made aware of what is going on in HQ and in other parts of the world, so that they can improve communication with clients, and in so doing the service they can give. In other words, unless information is of a highly confidential nature, do not keep it locked away, let someone else know it exists. There are so many occasions when an outport colleague says: 'I wish I had known that we are able to do that when I was talking to a client last week'.

To get more of this information spread abroad would be a colossal task and it may not be a job for the present Information Department, but it is essential if we are to continue to improve our image with our present clients and the many potential clients who are just around the corner. I would be interested to hear what Mr. Daniel has to say on this subject.

I would like to add my congratulations to Mr. Daniel on producing this paper, which to my mind is an excellent example of public relations.

Mr. C. F. ALGATE

Public relations is a subject about which many of us know too little. Maybe we have had an uneasy suspicion that it's only an excuse for wining and dining. If so, I'm sure this paper will go a long way to dispel this idea.

I should like to refer to a few specific points in the paper and raise certain questions about them.

There is a reference to the huge volume of industrial literature that is published. Does the Author consider that the point of saturation has been, or soon will be reached? And does he agree that at this point the exercise is self-defeating in that no one reads anything because of the overwhelming volume of printed material?

Exhibitions are said to reach saturation point from time to time in one industry or another. Are there yet any signs of this in the shipping industry? In Part 2 the Author describes some of the factors leading up to a management decision on exhibitions. Does he know what decision has been taken by our leading competitors?

Press relations are of major importance for Lloyd's Register, says the Author, and he describes the formal channels for issuing press releases. How important does he consider it to know personally the shipping and industrial journalists on magazines at home and abroad?

LR seldom figures in the big headlines of the daily newspapers, but when it does it is likely to be when a marine casualty hits the headlines. When the news arrives outside the 9–5 working hours, is there always a PRO 'on call' to answer questions from the Press?

I should like to endorse 100 per cent the statement that any clerk who deals with an enquiry on the telephone is involved in an act of public relations. It doesn't matter how routine an enquiry may be, there is no doubt that the enquirer is influenced by the manner as well as the level of knowledge of the person answering. This is a lesson which junior staff cannot learn too soon in their careers.

Mr. M. MERRETT

I would like to direct my remarks to an aspect of public relations which has only been briefly touched upon by the Author of this paper, namely the relations and communications amongst and between the Society's own personnel. Whilst agreeing that the primary *raison d'être* for PR in a firm is to improve its communication with its customers and potential customers, I feel that good staff communications is also a very important aspect which merits close attention. This is particularly so in an organisation such as Lloyd's Register, which employs a large staff on a world-wide basis. For Surveyors serving abroad, particularly those originating from the UK who may well return there at some future point in their careers, the sources of information about what is happening in their own country are somewhat restricted and certainly

include the one mentioned early in Mr. Daniel's paper, i.e. rumour.

One method of combating this undesirable way of disseminating information, which is employed by most firms of any magnitude, is a staff magazine. For example, the shipbuilding firm of Kockums in Sweden produce a quarterly magazine covering staff activities in their shipyards and ancillary works. If such a firm as this, with most of its employees situated in three or four main centres, finds it beneficial to produce a magazine, how much more desirable and conducive to a corporate spirit that this Society, with staff spread out all over the world, should have something similar. At one time we used to have a news letter giving particulars of births, deaths and marriages, transfers, promotions, etc., but if this is still published it comes out at such long and irregular intervals that it has lost any real value. It's not much use writing to a colleague to congratulate him on a happy event if it's a year old by the time you know about it.

Whilst this type of information should certainly be included in such a magazine, I feel there are many other subjects of considerable interest and concern to the staff which could be covered. Conditions in the industries served by the Society are changing and this has meant, and will continue to mean, changes in the methods and conditions of work within the Society itself. Articles in a staff magazine would be an excellent means of informing the staff about such changes and explaining how they might affect the individual person. Just recently we have seen the formation of the new Staff Consultative Committees whose job is to provide a two-way link between management and staff. Would it not be possible to use such a magazine for informing people about the matters being discussed by these committees. Information about the Society's arrangements for staff welfare, health and housing, transfer and repatriation, London allowance, foreign allowance, even salaries could be given and explained. For many Surveyors and their wives who are transferred abroad it would be a great help to know something about the conditions they are likely to meet in their new surroundings. This could be covered by a series of articles by people already serving in these countries. News of past or forthcoming sports or social events should also find a place together with news about or for pensioners.

I have heard it said that all these facets are already covered by existing notices, codes of practice, etc., but this is not a valid argument since conditions are always changing and many of the formal sources of information are either out of date or lost amongst the maze of paper which engulfs us all. Information given in a bright, informative, well produced magazine published every two or three months would be up to date and live and serve a useful purpose in reminding its readers that they really do all belong to the same firm. In my opinion it would be much appreciated by many members of the staff, particularly those serving in isolated and out of the way places throughout the world.

In conclusion I would like to thank Mr. Daniel for a most interesting and informative paper.

MISS E. E. PARKES

In the light of my own experience I would like to make some points which relate to the value of public relations.

PR activity seems to me rather like the air you breathe. When it is there you don't notice it, when it is not there you feel the consequences, and these are loss of morale, loss of business and loss of recruits.

In my first days in Lloyd's Register I was working as secretary to the gentleman who combined the titles of Chief Executive and Secretary, offices which in those days took in the functions of Controller of Personnel as well. This was at the time when Lloyd's Register had virtually no organised public relations and when Det Norske Veritas, in particular, were embarking on an intensive PR campaign. It was my job to open the mail and by almost every post letters arrived from outports, particularly in Scandinavian countries, complaining of the discouragement felt by Surveyors. Wherever they went, it seemed that NV had been before them. They were constantly being told of NV research and practices, and when they countered this propaganda by assertions that LR was doing just as much, or had been doing it for years, their assertions came too late to convince. During that period and subsequently, NV increased its fleet by a substantial amount and I am sure that the lack of organised public relations cost LR dear.

On the question of evaluating exhibitions I agree that it is notoriously difficult and for this reason particularly efforts were made to record contacts made at the Society's stand at the Hamburg Ship and Machinery International exhibition in October 1972.

Discussions took place, and names were exchanged with representatives of 68 shipyards, 66 German firms (38 outside Hamburg), 16 shipowners and/or their representatives, 45 firms outside Germany, nine institutions and publishers, 12 German Government authorities and 14 universities and colleges. Countries in the 'outside Germany' category were Argentina, Cuba, Denmark, Finland, France, Great Britain, Holland, Iran, Italy, Korea (South), Norway, Poland, Spain, Sweden, United Arab Republic and USA.

Some of the enquiries were such that, if even one were to come to fruition, it would pay for our stand and probably more.

There is another aspect. It is agreed that Lloyd's Register must make its services known to a whole range of new publics. As a professional body it does not advertise and therefore, unless there is a change of policy, *public relations remains the only way*. The Society *has no other means* of getting information about its activities over to its potential clients. And one must remember that potential clients are not only shipowners already known to us who might order another ship and who can be reached by direct mailing. They include *entrepreneurs* who may never have had occasion to use or hear of any particular LR services.

When the Society embarked on the certification of containers, some six years ago, it could not possibly know who its future customers would be. All sorts of firms went in for the manufacture of containers and these could only be reached by casting the net wide, through the press and other media. Incidentally, it is perhaps entrance into new fields that provides the most profitable opportunities for exhibiting. I believe those who took part felt that LR participation in earlier container exhibitions did much to put the Society on that particular map and to further useful contacts.

Finally, if I may add to my remarks at the time, one speaker has expressed his distress at the confusion he has found on many occasions between Lloyd's and Lloyd's Register. It exists and it is bound to exist, as long as there are two organisations with titles which indicate that one is a branch of the other, both of which publish shipping intelligence. I don't

think it does either organisation any harm as both enjoy high reputations. Indeed, I have been told of one overseas gentleman who was so impressed with the Corporation of Lloyd's on a visit there that he went home and switched the whole of his fleet to Lloyd's Register class. The main point is that people should know what Lloyd's Register has to offer, whether they think it is a branch of 'Lloyd's' or not.

I have long thought, however, that instead of tolerating this state of affairs, harmless though it may be, we should turn it to advantage. It seems to me absurd that an enquirer should have to ring Lloyd's Corporation for news of the latest casualty, and Lloyd's Register for lists of casualties, Lloyd's Corporation for movements of ships and Lloyd's Register for details of the ships themselves. Lloyd's and Lloyd's Register between them must have a wealth of immediate and long term information on shipping, possibly unrivalled anywhere in the world. I believe if both services were linked, identified as a shipping information bureau and given a joint address and telephone number, the impact would be vastly greater, though the cost need be little more. If resources were pooled, would we not have an information bureau more informed than any other? And might this not be an opportune moment to examine the possibility—before other institutions overtake us and as we enter the EEC, with its great share of the world's shipping and trade?

Mr. W. A. Cook

One is left in no doubt, after reading this most informative paper, of the importance which should be attached to public relations and it was most regrettable that, being indisposed, I was unable to contribute to the discussion and view the film which, I understand, very ably supported some of the views expressed by the Author.

Public relations, as we know of it in Lloyd's Register, has contributed so much to the well being of this Society, and colleagues both at home and abroad, especially the latter, have played an important part in keeping open the channels of communication with clients or potential clients and have accepted it as part and parcel of their every day responsibilities.

Owners' representatives, who were entrusted with decision making respecting the classification of the new construction being projected, relied considerably on the Society's representatives, not just from a technical or practical aspect in the design and construction of a ship, but sought friendly advice and relied on the Surveyors' local knowledge. People of such standing, until the early 1960s, looked to Lloyd's Register Surveyors for guidance into the many problems they were often confronted with and such good relationship prevailed for many years and still does, but to a lesser degree.

The contents of the paper has made this kind of public relations look rather elementary, but it paid dividends, and I am sure many a reader would support me in these views.

Between the 1950s and 1960s our younger competitors, which the Author describes as being keen, pushful and able, began to make an impression in the shipowning and shipbuilding communities of the maritime nations of the world, notwithstanding that in the early 1950s the Society was taking care, in some countries, of the interests of those who we now know are our foremost competitors.

The self styled PR men of the Society continued with renewed efforts to attract clients and it was not until early in 1960 that opposition not only came from our 'young competitors' but we found a change of heart in the shipbuilders and eventually the shipowners, where decisions of the technical staff took second place to those of the financiers.

So one could rightly claim that this paper is long overdue for presentation to the staff as it has given a 'new look' to public relations, as we once knew it in Lloyd's Register. This should surely encourage all members of the staff to participate in the field of public relations which is of such vital importance to any successful organisation or business.

Public Relations and Management

The Public Relations Department is one of the non-fee earning sections of our Society and one can well imagine that, before any publications are launched in to the market, the cost of production is carefully assessed and its value to the readers carefully considered.

PR work for a technical Society such as LR is not very rewarding. It is most difficult to measure the success of any publicity campaign, regardless of whether it is an exhibition presenting the services the Society has to offer, or if it is the distribution of a newly compiled brochure.

Our public is small, selective and wildly scattered and its interests are unavoidably slow to mature.

This paper has highlighted some of the questions which are frequently asked in the Society: Why doesn't Lloyd's Register publicise itself more than it does at present? Why don't we review our brochures more often and endeavour to accomplish a wider circulation?

Under the section of industrial brochures, the Author has defined some of the problems associated with PR work. It is true to say that the production of literature should be most deliberate and calculated. I would, however, ask for his opinion whether the Society should concentrate on the production of thinner brochures and distribute them more often than at present, or use more freely the advertising columns of the national newspapers of countries in which we operate.

There are only a few ways by which the Society can measure the effect of its public relations influence on this selective public: (a) successful marketing, (b) clients' confidence, (c) customers' satisfaction.

Industrial Literature

Considering the limited variety of literature the Society's activities will permit it to produce, and its limited readership, it is most essential that to obtain the best results for the efforts made, we must be rather selective in its distribution. If the literature is not directed to a defined readership, then I feel certain that the message we are endeavouring to 'put over' to the industry will not make the impact that we are hoping for. It is only through such media that it is possible to reach the innermost sanctuary of marine and industrial organisation, unless of course we employ a sales force of some magnitude.

A handy size brochure, well presented, can be the Society's 'best seller' and the most useful means public relations have in getting the information we require to impart to the desks of managerial staff, where invariably our technical and administrative staff cannot penetrate.

It is through publications and press media that the way is prepared for the marketing staff to create a 'need', which will encourage prospective clients to seek more information about our service, alongside which we can then offer classification.

In some outports I have sighted mailing lists which have contained names of persons who have either reached the age of retirement or have passed on to the 'happy hunting

grounds', but the material is still sent to them.

Would the Author agree, that a simple questionnaire should occasionally be sent to each firm or person on the Society's mailing list or others whom we may think would be interested in the literature and enquire the following:—

1. Are they interested in receiving LR literature?
2. Have they any preference?
3. To whom should it be addressed?
4. Names of any associates who would find LR of interest?

By such a method the Society may be able to introduce some economy into what must be a very expensive publicity undertaking.

Exhibitions

In the second paragraph of the section under this heading the Author gives us three main reasons of viewing exhibitions, which he has termed a lucrative business for the organisers.

From my knowledge of exhibitions, in which the Society has participated, it would appear that up until about three years ago the last of the categories has been our aim, but in recent years the second category has undoubtedly been our prime consideration.

In these latter years certain members of the Society's staff both at home and abroad have become publicity minded and marketing orientated as they have been in the advantageous position to project the image of our highly qualified techn'cal services which are additional to classification.

I do not believe that the Society should participate too often in exhibiting the services we have to offer the community at large as, whilst the cost is rather high, for the measure of success we appear to achieve, we could, if we were not selective in our choice of exhibitions, cheapen our image in the eyes of our competitors.

We must not lose sight of the fact, however, that an exhibition of some kind or the other is the only shop window of the world available to the Society where we can display our technical services. These shop windows, prepared on behalf of LR have done credit to the skills and imagination of the Public Relations Department coupled with the support they have received from managers and staff of the country in which the exhibition took place.

Corporate Identity

One could contribute criticisms of failure to project the Society's image and lack of appreciation for good sound public relations. One glaring example of this is from our technical staff who, from the days of their early initiation, have invariably failed to present themselves as 'Lloyd's Register' Surveyors. The common introduction has been a 'Lloyd's' Surveyor and even in the marine fraternity this has been mistaken for a Surveyor representing an insurance company. This has oft-times been confirmed by Masters and Officers of vessels who, after a special survey has been satisfactorily completed, have enquired if a recommendation will be made to reduce the insurance premium.

Shortly before the paper was presented to the staff, a press photograph was received of one of our technical colleagues being introduced to a VIP, at the commissioning ceremony of a ship for a foreign power. The caption reads: 'H.E. so-and-so being introduced to Lloyd's Insurance Surveyor'—hence the importance of clearly identifying the Society. We must, therefore, do everything possible to clearly project a favourable and accurate image, as unlike most of the other classification organisations, our name does not identify the Society with its country of origin.

Marketing

I would now draw attention to the section of the paper in Parts 1 and 2 on marketing.

The public relations section of any forward-thinking organisation, is of prime importance to the marketing division, as, without proper and sincere intervention, it would be hopeless for a marketing team to go into an area and expect to achieve a reasonable measure of success.

We must, therefore, accept that public relations is the spearhead of marketing and it is part of the Society's functions which must open up a channel through which the marketing staff can communicate in order to achieve the best results for the least available time and expense.

It is, however, evident, especially when considering the Society's approach to marketing, that public relations is a most essential part of our image-building machine, because, although we have been nearly 213 years in existence, the image of those 'yesteryears' is not the same as the one that we require to present to the industry in modern times.

Although, at this moment of time, the Public Relations Department is separate from the Marketing Department, as clearly shown in Fig. 4, I do anticipate that, in time to come, for efficiency and economical reasons, the departments will merge. It appears to be unreasonable that there should be two channels of approach to top management when the departments have responsibilities which aim for one goal.

The Author states that he does not think that it is a desirable arrangement to have the public relations staff under the same umbrella as marketing because the PR staff are usually concerned with many other things besides marketing.

This is perfectly true, but when we come down to basic facts, the other activities in which public relations are concerned can ultimately mould in with the marketing concept. After all, it is marketing and creating a 'need' for use of the Society's services that we are all primarily concerned with.

Employee Relations

No matter what the feeling might be towards an owner's failure to comply with the requirements of the Society, we should always endeavour to phrase letters in such a way that the recipient will have no cause to complain of the phraseology. At the same time, the letter should be composed so that he is made aware of his responsibilities.

This same principle should also apply in the exchange of correspondence with staff. I well remember at a port of my first posting abroad, where a colleague, who was a national, received a reprimand from HQ in the form of a letter which opened with the following: 'The Committee is greatly "exercised" by the content of your report, etc., etc.' My colleague was very confused and somewhat concerned at the harshness of the phraseology. He could not understand some of it until after he had consulted the English dictionary. The immediate response from certain members of the staff was a cartoon depicting members of the committee doing hand-stands, and other physical exercises.

Conclusion

Thanks to the Author, the Society's staff throughout our world-wide network of offices will now have a better understanding of the work undertaken by Public Relations Depart-

ment, and will no doubt further appreciate its responsibilities both to management and staff in general.

To compile articles which relate the true interpretation of the Society's activities without distorting the literature in order to make it sensational, must at times be rather a difficult task. We find so much sensational matter in the public press, and yet to make it attractive to its readers is of great importance. The national press is widely read, but invariably in the 'Best Sellers' the articles are sensational, but the paper loses its value.

Mr. C. R. J. HALL

As a comparatively new member of the Society's staff I would like to express my thanks to the Author and to all those participating in the subsequent discussion for what I found an interesting and informative meeting.

My work as a member of the job evaluation team has brought me into contact with many of the Society's non-technical staff in HQ departments, particularly the more junior members who are furthest removed from senior management but who nevertheless make an important contribution to the Society's activities. My perception of the Society must be from what is an unusual angle, but I believe it is also an important one, and because of this I would like to take the opportunity of offering some comments to this discussion—comments on the Society's corporate identity, but from the point of view of employees rather than clients.

Those who work for organisations in consumer goods industries usually come into contact in everyday life with the products they have in some way helped to bring into existence, and many firms have realised that to encourage their employees to take an interest in their products by teaching them about them, enabling them to purchase them at cheap rates and so on is an important way of enhancing the identification of the employee with the organisation, encouraging him to take a pride and interest in his work. This is a particularly difficult problem for the Society, whose products are complex technical services readily understood only by applied scientists in fairly specialist fields. It is a problem that must always have existed, but I believe the Society was able to deal with it in different ways in the past, and did so. Thirty to forty years ago it was a much smaller organisation, Britain's educational system was different, and social norms were stronger and more clearly defined than they are today. The Society recruited its clerks from a comparatively uniform social and educational background and fostered team spirit through active encouragement of recreational activities. People grew up in those times to believe that to have a job with security was of such benefit that to question the nature of the work, or why it was done, would be the height of folly.

The different system of education today, coupled with the generally less authoritarian social outlook, has led to expectations of those entering employment for much greater understanding of, involvement in and leave to question the work they are asked to do, and it is through these means that people now tend to look for identification with the organisation they work for. The Society cannot and does not practise the methods of the past now, but it has not put anything in their place. I believe it would pay dividends if it were to take steps to greatly improve the standard of technical education in many of its non-technical areas, so as to increase the involvement of staff in those areas with the technical services which are its product and its bread and butter. I also think it would be beneficial for it to examine its organisation structure to ensure that co-operation between technical and non-technical areas is maximised.

I am, I know, speaking prematurely to a certain extent, since I have experience only of HQ departments and the problem has not yet been systematically researched. If it were to be looked into, however, and my findings were subsequently validated, then I feel the solution of this problem would go a very long way towards solving some of our administrative difficulties such as poor communications, slowness of clerical processing and escalating non-technical establishments.

Mr. A. K. BUCKLE

It is stated on page 12 that the presentation of papers to invited audiences is cheaper and probably more effective than exhibiting. I will agree on the effectiveness of papers but costing surely depends on the method of accounting. I am currently scheduled to present a paper on average once every six weeks. Every one is different and very few are to be subsequently printed. The cost per head of the 'public' attending talks is very high—say £10 if my estimates of total cost of about £500 per paper are correct, my costing being taken to include overheads for the accommodation of the typists, technical illustrators, etc., as well as their salaries. Printed papers offer much better value for money. Technical Association papers are an excellent example of this, at least one such paper ran to over 8000 copies, excluding a full reprint in a technical magazine with world-wide circulation.

May I stress the need for an improved 'in house' information service. With an organisation as large as LR loyalties only extend as far as communications remain reliable. With inefficient communications different departments start to compete instead of co-operating, and empire building then takes over and destroys morale. An unhappy employee is a bad ambassador.

How is the public relations budget determined? When I was a member of the committee organising the Billy Graham Crusade in Nigeria we were advised by our publicity consultants that we could advertise at one of two levels, (a) to inform, or (b) to persuade. Any expenditure below that needed to inform was a complete waste. Any expenditure in the range between (a) and (b) would also be wasted (for our purpose the ratio of (b) to (a) was set at 4:1) and any expenditure in excess of the minimum needed to persuade was subject to the law of diminishing returns. We listened politely, considered it all too simple to be wholly true, spent all we could afford, prayed a lot and filled the race course every night for a week. Is LR trying to inform or persuade?

Just what is LR supposed to be offering to industry? We are continually being told that we are offering a unique service, but is this really so? If our product is in demand we should have a number of commercial competitors by now, in which case we are not unique. If our product is not wanted we would be broke by now—and we are, in fact, growing. Could it be that we are kidding ourselves that a rose by any other name smells quite different, when it doesn't? Could it be, in fact, that our main competitors are not state-backed classification societies but home grown consultancy and inspection firms?

Before we cease all expenditure on exhibitions could we not splash out a little in head office and use the exquisite drawings and models to stress our progress? The addition of a few up-to-the-minute drawings of VLCCs or LNG ships in be-

tween the composite ship drawings on the second floor is long overdue. An electronic time measurer next to the ship's bell would tell its own story. A North Sea fixed platform, to the same scale as the *Mauretania* would completely change the impact of the *Mauretania* on visitors. There are many reasons why we should be proud of LR. Please help us to be proud by right.

Finally, would it not be worth while for someone to list all the colour slides in the Society's possession, together with an indication of their location so that they are available for use. At present it would seem that less than 10 per cent are listed and most are lying, little used, in various Surveyors' drawers.

Mr. N. J. TURNER

At the presentation of Mr. Daniel's excellent paper, I was pleased to note the general level of awareness shown by Mr. Daniel and subsequent contributors of the need for the Society to project itself in the 'market places', to obtain the necessary business on which we all depend.

There is no doubt that in these days of intensive competition in all spheres, even the most well established firm or society has to be concerned with its image, and the markets in which its products are offered for sale.

Mr. Daniel mentioned the selling operation almost in passing in a paragraph under the heading 'Marketing', in which he gave a useful summary of that function in Part 1 of his paper. Under the same heading in Part 2 appears the sentence 'In the shorter term public relations methods may be used in a promotional way to stimulate interest in, approval of and, hopefully, purchase of services . . .', hopefully, purchase of . . . .

This indicates an almost apologetic approach to selling, to the sales function, which should be of paramount importance. Unfortunately, many engineers and others have this approach, often impeding or even deriding those engaged in sales, forgetting that such people must be sufficiently qualified to speak with clients and/or their engineers as equals.

In the majority of firms in the commercial world, public relations and marketing are subordinate functions to, and provide vital support for sales, as it is upon the success or failure of the sales operation that the company will flourish or decline. It should be noted that the term 'marketing', which appears more acceptable, is frequently being used as a substitute for sales. There is also a blurring of the interface between the two functions, but sell you must.

I would like to briefly illustrate how emphasis on the sales function or lack of it has affected the performance of two companies I have been privileged to be associated with.

Following the last war, the first company started with a very small establishment assembling imported parts to produce a saleable product. No assistance beyond that initially given for a small staff was available, but a constantly increasing sale of a good quality product was established, enabling the company to increase in size. Everything was geared to sales and a strong sales element built up. Within about 15 years that company had completed its own UK head office, established various factories, and opened area offices, offering a full range of equipment for industrial and allied fields. Further, it is recognised as a leader in the areas in which it operates. Over the last ten years, this company has developed interests in the computer industry and now occupies a leading position in that industry.

All this has only been achieved by a constant emphasis on sales, and constant training of personnel in that function, with the allied marketing, PR, literature, projections for manufacturing departments, etc., under a sales directorate. A favourable company image that all strive to maintain has been built up and is widely recognised.

The second company was a large and influential member of a group of companies in heavy engineering, and at the close of the last war a leader in its field. The order book was so full that for some considerable time the company had difficulty in meeting all their obligations. During this time and subsequently, the only recognition the sales function received was in the preparation of tender documents under an executive grade engineer with a small staff. After about ten years, with the growth of competition and unit size, orders began to fall off. A decision to increase the manufacturing facilities was taken, and a great deal of money spent. No attempt to find alternative markets was made, not one sales engineer was appointed and although a major contract was concluded for the new manufacturing facilities, within the following ten years, the group management closed down production of rotary plant, but leaving a considerable facility for other equipment. However, within a few further years that company ceased to trade although the unprecedented step of appointing one sales engineer was taken—too late. The ultimate step was the establishment of a new factory in the area by a competitor manufacturing similar equipment.

The moral of these two tales is obvious, and as a very new member of this Society, I have been most encouraged to hear both at this meeting and others, how the Society is diversifying itself to meet new requirements and how people are identifying new areas where the Society's expertise can be utilised and sold.

The results of a sales approach to the work of a classification society are much in evidence in the recent upsurge of DNV, a point commented on by various speakers. I had personal experience of this, as it became necessary to be as aware of DNV requirements as of LR requirements when subcontracting to various yards.

Similarly, the misunderstanding of the identity of the German branch of LR, i.e. Germanische Lloyd, is quite widespread. By use of the name 'Lloyd' a great deal of the LR image has rubbed off, at least for the uninitiated.

No matter what word is used to describe the basic function of sales, all related efforts should, in my opinion, be directed and co-ordinated by a full-time director who is party to top level decisions. The whole effort designed to increase the business coming into the Society would thus be under strong central direction, within a single wide ranging department.

I have merely touched on an aspect not greatly emphasised in an attempt to add to the value of Mr. Daniel's paper and the subsequent contributions. Many excellent practical points on the sales approach were made in the film, and it underlined Mr. Daniel's plea that everyone is a PRO for the Society.

This contribution is offered from what may well be a different background to many who have done and are doing so much to give the Society its present respected name and income.

Mr. G. J. ATKINS (Southampton)

Having read Mr. Daniel's paper, I am moved to contribute to the discussion as one of those outport Surveyors who 'seem to do as good a PR job as their conditions allow'.

Outport Surveyors do an absolutely first-class job of public relations, each and every day, year in, year out, and have done for generations. Most shipyards and most superintendents would have no hesitation in confirming this. Outport Surveyors' public relations are really put to the test when discussing repairs with an owner's representative whilst lying in confined oily spaces, whilst standing in dry docks in the teeth of blinding snow, whilst standing on boiler tops having come out of frozen chambers, quite often with a view to making the owner's representative spend thousands of pounds—or helping him to save thousands of pounds! This goes on every day throughout the world and is, in my opinion, far more important public relations than paper advertising from London office.

The Outport Surveyor 'sells' the Society every time he visits a shipyard, has a talk with a design draughtsman, discusses repairs with yard managers, chats with the welding foreman and is present at the yard lunch table with owners' representatives and potential clients.

Whilst I wholeheartedly agree that the Society has to advertise itself, its computer facilities, accumulation of 'know how' (because the whole object of advertising is to sell our services), I do think that insufficient recognition has been given by the Author to the outports. After all, the outports are usually in a position to alert the Marketing Department about possible impending contracts, *before* they reach the *Financial Times*.

With regard to obtaining LR classification of new ship contracts, I am quite sure that shipyards are less likely to be influenced by advertising than they are by the amount of red ink which might be put upon their nice new plans by any classification society, with consequent upsets of their intended programmes. We must not underestimate the pressure which can be exerted by a shipyard upon a shipowner with respect to the choice of a classification society, and our chances of obtaining this work would not be enhanced if we had poor public relations between the yard and the Outport Surveyors in the first place.

Can I give two instances, which occurred within the last two months, of Outport Surveyors' public relations quite unconsciously uncovering the reasons for two lost contracts.

When having lunch with a shipowner it transpired that he was not having his new ship classed with us because an outport 'had not replied to one of his letters' concerning repairs in connection with survey of an existing ship, and this discourtesy was accordingly remembered as inefficiency. Within an hour of returning to his office, we had telephoned the outport concerned and relayed the 'missing' letter to him. Two hours later the shipowner telephoned to say that it was his own office who had filed the letter without informing him, and therefore his apologies were profuse. Too late, the class of the ship had been lost, through lack of public relations in the outport.

The second instance was again whilst talking to the manager of a division of a very large organisation, he informed us quite happily that he had *all* his Continental sub-orders placed with Germanischer Lloyd. He was so disappointed to learn the reason for our lack of appreciation! However, because of outport public relations he is to amend the orders in the future to LR survey.

These are only two instances of how we depend upon outports' public relations; but multiply this by the one and a half thousand Surveyors who can possibly influence contracts, then the end product is such that recognition should be made in the paper.

I was not very happy to see that a most important public relations activity of the technical staff had been rather casually referred to in brackets '(papers are often read to professional institutions, of course, and are of great value in drawing attention to the technical thought of the Society)'.

Mr. Daniel does not fully realise that Surveyors are staunch supporters of their professional institutes, often being active committee members, and are thereby exercising public relations not only with colleagues in all allied industries but also with owners, or owners' representatives, as existing or potential clients.

Mr. Daniel feels that many prospective employees of Lloyd's Register are unaware of its existence at the time of leaving school, or know little about it at the University stage. This I find very surprising indeed and can only assume that it is applicable today because of the diversification of our services.

Strangely enough, reference to a management consultant manual showed that public relations, as such, were never mentioned, but marketing and advertising were of course fully dealt with.

Reference to selling short-term products such as Coca-Cola, or British Railways, etc., can hardly be used as a basis for advertising our Society, because, although it has been said that we do not sell an instantaneous product, it is true to say that this same product is maintained for the next 20 years or so—primarily by outport man-power.

Can I make a plea to further the internal relations within our own Society, as suggested in the conclusion to the paper, whereby in the next edition of '100A1', a photograph of each and every outport staff (the whole staff) and also London departments be progressively printed in successive issues, thereby bringing the Society's staff closer together?

Mr. O. NILSSON (Gothenburg)

The Author has presented an interesting paper on the application of public relations to the Society to which I would like to comment briefly.

What Lloyd's Register has to sell, apart from limited editions of books such as the Register Book and the Rules, is 'know how', 'know how' of modern technology predominantly in shipbuilding. 'Know how' is an abstract thing and marketing of this product needs the support of expert communications, particularly that of the press medium which must be considered the most important means of public relations for the Society.

It may not always be an advantage to refer back to the famous past of Lloyd's Register, and I certainly share the Author's opinion that the belief that the Society is less forward looking than certain other classification societies has been prevailing too long.

The Author speaks in favour of good internal public relations and no doubt the internal information system of Lloyd's Register works very well, for instance the Technical Association plays a role here. I feel there could be room also for some lighter publications and would be interested to know whether the 'News Letter' will continue.

To be a classification Surveyor means to work under unusual personal responsibility and the decisions taken will be judged long afterwards, e.g. when the report is examined. I am, therefore, glad for the statement by the Author emphasising the role *all* Surveyors play as PR officers. I have often

heard superintendents express their appreciation of Lloyd's Surveyors abroad, and this is the type of reputation we need and must maintain. A little extra effort costs nothing but means so much in order to build up our image. In this connection I would like to draw attention to the interim certificate, which may be called the owner's receipt for a survey. I think this is the most important document issued by Lloyd's Register also in the narrow sense of public relations, it is at the same time the written proof that the 'know how' we claim to have really exists.

The Author has not touched upon the important subject of how public relations should be used when the Society is met by criticism. Indirectly it is covered by the statement: 'The management is responsible for information policy', which is natural. I would, however, like to hear the Author's professional opinion on the matter. Would, for instance, a special Press Officer speaking on behalf of the management be a realistic solution?

AUTHOR'S REPLY

First, I wish to thank all my colleagues who have contributed to the discussion.

Since similar or related points were raised by a number of contributors, I am arranging my reply under headings.

Press relations

It is, of course, very important to know journalists personally. Good Press relations are founded on mutual confidence between Press Officer and journalist, each understanding the other's attitude and problems. This friendly relationship can only be achieved by personal contact. It takes time to establish and, once established, it must be jealously protected.

Mr. Nilsson raises an interesting question on the use of public relations in countering criticism.

One may postulate three basic kinds of criticism: (a) well-informed, (b) ill-informed, and (c) malevolent.

As regards the first, if the criticism is justified, there may be little that one can do but be seen to be trying to put matters right. It is seldom wise to try to deny the truth, though it may be possible occasionally to employ diversionary tactics of some kind.

In the case of (b) and (c), however, the critics themselves are usually vulnerable. It may be possible to place letters or articles of direct refutation in the Press, to enlist the aid of journalists by calling a conference, or secure an interview on television, for example. Another approach might be to ensure that important opinion groups are given the facts and allow them to exert influence on one's behalf. The case will usually suggest the means.

But these are responses to criticism and are therefore second best. Far better to defeat these kinds of criticism before they appear by ensuring that the public is as well informed as possible. If the public, in the light of its own knowledge, can see that criticism is probably unfair or ill-founded, the battle is more than half won. That is one of the important reasons for seeing that a steady flow of information is directed towards the various groups that make up the Society's total public.

As a general comment on this point: dealing with criticism is always a delicate matter and it is necessary to guard against over-reacting to something which, on reflection, will be seen to be of minor importance. Sometimes, 'least said, soonest mended' is the wisest attitude.

The suggestion of a 'special Press Officer speaking on behalf of management' does not commend itself, for two reasons. First, a Press Officer must be speaking for management in any case. There is no one else he can speak for. Second, the appointment of someone different to speak on special occasions, such as when answering criticism, could produce an unfortunate effect; for it might be thought that his purpose was to conceal rather than to inform, and if that happened the management itself would come under suspicion. The confidence of the media is never more important than when things are not going too well. Any politician knows that.

Mr. Algate wonders if there is a Lloyd's Register PRO on call outside working hours to deal with Press inquiries. Very occasionally an inquiry is dealt with outside office hours, but there is no formal roster and little purpose could be served if there were. When a marine casualty occurs, the immediate response to inquiries can never be more than to supply or confirm details about the vessel concerned from the Register Book. Technical comment is out of the question in the early stages, when virtually nothing is known of the case; and even later, it may be precluded by the likelihood of an official inquiry being held or because it is not proper to discuss a client's problems, or some such reason. And comment of a political nature or on any other matter outside the Society's competence is not to be considered. If it were thought necessary for one or two members of the Public Relations Department to keep sets of the Register Book and supplements at home, it could be done, but most newspapers have their own copies for reference in any case.

Exhibitions

There are indications that saturation point has been reached once or twice in the shipping field.

In the 1960s there was an attempt to create what one might call a 'Nordic circuit' of marine exhibitions. Events were to be held in Oslo, Gothenburg and Helsinki so that there would be a major show in one place or another almost every year. The 'Navigare' exhibition took place in Helsinki in 1963 and 1967 and was then abandoned. The Sea Transport exhibition in Gothenburg was held in 1967 and 1969. In the latter year it clashed with the first Posidonia exhibition in Athens—and died. Only Nor-Shipping, held in Oslo in 1965, 1968, 1971 and again this year (1973), has survived.

In London, Ships' Gear International struggled through a third year before it expired. On the other hand, Ship and Machinery International at Hamburg seems to be gaining strength, as does the Posidonia series in Athens.

Also in the 1960s there was a spate of container exhibitions. One British company promoted in quick succession a series of container exhibitions in various parts of the world; but again the steam went out of the business because people got the industry into perspective.

The most successful marine exhibition so far, in terms of longevity, is the big Europort show, held annually in Holland for the past 11 years.

Other classification societies have been much less involved in exhibitions than Lloyd's Register. The American Bureau of Shipping has generally refrained from exhibiting, except at

Posidonia. Det Norske Veritas has always supported Nor-Shipping in Oslo, but has not exhibited outside Norway. However, both these societies have entered the International Marine Exhibition (IMEX) in London this year and a recent conversation with the Public Relations Officer of NV leads me to suspect that that society may be changing its policy.

Mr. Buckle queries the suggestion that presenting papers to invited audiences may be cheaper than exhibiting. I confess that I had been thinking mainly of papers which would ultimately appear in print, either as Technical Reprints by Lloyd's Register or in the proceedings of learned or professional institutions. Admittedly, assuming Mr. Buckle's estimate to be supportable, the once-only papers given by him do look rather expensive. Wherever possible, more 'mileage' should be extracted from his and other people's efforts by getting them published, perhaps in various newspapers or magazines around the world. In any case, it is always advisable to have the texts available to meet the requests that frequently arise after papers have been delivered.

Industrial Literature

Mr. Algate asks whether saturation point has been reached and if the production of literature is not therefore self-defeating.

This is difficult to answer without a basis of facts, and I have not seen a survey on the subject. My guess is that the position varies according to the type of literature and the sort of people it is aimed at.

Most people in managerial or otherwise influential positions are asked to read far more than they can handle. The producer of literature, therefore, must try to see that his printed matter is of the kind that will be read. This does not necessarily mean printing the brightest cover or the largest number of colour pictures. These days, I believe, usefulness of content is the most important factor; and although a striking cover may catch the interest, if the content does not hold it, the publication fails.

This relates to Mr. Cook's query as to whether we should concentrate on thinner brochures and distribute them more often. If there is a purpose which calls for slim, cheap brochures—and such a purpose might be to put across a particular message quickly and in easily assimilable form—then they should be produced. But it would be unwise to concentrate on them for no other reason than that they were thin and cheap.

Mr. Cook refers to outdated mailing lists at outports and proposes using questionnaires as a means of checking whether our literature is getting into the right hands.

For more than a year past the Communications Department has worked hard on the problem of mailing lists, with the result that *all* the lists have now been revised and henceforth they will be regularly updated.

The major part of the distribution is outside the UK and, naturally, the outports are expected to see that the right people are on the lists for their countries. It may be that some people, who should get our literature, do not; but the local Surveyor, if he suspects this to be the case in a particular firm, say, can check. If the list has been carefully and thoughtfully compiled in the first place, there should not be a significant wastage rate. In any case, one can normally expect only a percentage response to a questionnaire, and often a fairly low percentage at that, so most of the gaps in the distribution or the points of wastage would probably still be missed.

Marketing

Several contributors wish to bring public relations under the marketing umbrella. Mr. Rengger says 'it is essential that publicity and PR operate within the overall marketing sphere and it is for this reason that most large organisations . . . are structured accordingly'.

With all respect, I must question the last part of that statement.

The Du Pont corporation has a large public relations department with functions of counsel and service. The corporation's official memorandum on public relations makes no reference to marketing, except to mention that some public relations people provide 'information services in support of marketing'.

In the British Oxygen Company, the Chief Executive, Public Relations and Marketing Services, controls all PR, advertising and marketing. But his role seems to be one largely of co-ordination and it does not appear that either public relations or marketing is subservient to the other.

At Tube Investments there is a Director of Public Relations. Marketing does not appear in his area, except that there is a market research manager within the PR set up.

The Chrysler Corporation goes so far as to lay down specifically that public relations does *not* have responsibility for, among other things, advertising, shows and exhibitions, dealer relations or communications and sales promotion.

In none of these cases is there any suggestion that public relations is subservient to marketing. In fact, the wider activities that I mentioned are strongly recognised. Whilst these wider activities may 'ultimately improve marketing prospects', it is surely straining the argument to suggest that PR in the fields of, say, recruitment, education or community relations should come under a head of marketing.

It is very doubtful that either efficiency or economy will be served by merging public relations and marketing departments. At the most they might—each retaining its autonomy—be placed under a common co-ordinating overlord. Since both activities call for their own kinds of knowledge and skill, there could be no economy in terms of manpower by merging the two. A public relations department can benefit its organisation best by being a service and advisory department, co-operating with others in various areas as necessary.

Mr. Rengger raises the question of advertising. As far as Lloyd's Register is concerned I think advertising is a tool which should be used with caution, *if* it is used at all. Perhaps it may be best used in a relatively short term way to promote a particular service. However, the act of advertising naturally stimulates approaches from space salesman representing all sorts of publications, so it is necessary, in order to deal with these approaches sensibly, to have a clear idea of what it is hoped to achieve by advertising; and that implies a budget and a planned programme.

* * * *

Mr. Harrison invites me to comment on a number of his remarks, but I can only say that they are statements with which it is difficult to disagree. He does, however, raise the question of 'the proportion of a budget that can be, reasonably, devoted to such activities' (i.e. public relations).

This is almost impossible to answer. The two obvious approaches to the matter of budgeting are: —

(a) Allocate a sum of money and do the best you can with it;

(b) Decide what you want to do and see if you can afford it. If not, modify your objectives to whatever you can afford.

The first approach is too arbitrary, too hit-or-miss.

The one thing that can be said is that spending too little on public relations can be a waste of money. That does not mean the sky is the limit. It means simply that a programme is unlikely to achieve the desired objective if it is inadequately financed; or that too little money will not support the programme that the situation may really demand.

Mr. Rengger asks for my first 'attack line', given a 'free hand and an adequate budget'. I fear I cannot give him the kind of answer I suspect he would like.

In the first place, a public relations practitioner does not want what is implied by the words 'free hand'. His job is to collaborate with his clients or his management, to discover their policies and their aspirations and to formulate a programme aimed at achieving certain agreed objectives. At that point he asks, not for a free hand, but for the authority to carry out the approved programme, freedom from interference in exercising his professional skills, and an adequate budget.

The nature and scale of the Society's operations is such that there is a need for a continuing basic programme of informing a widely varied audience. On top of that, target groups may be singled out from time to time for particular attention with a specific aim in view. But it would not be proper to discuss priority objectives here—and without an objective one can hardly talk about an 'attack line'.

In conclusion I must acknowledge the dissenting voice among the contributors—Mr. Atkins, to whom I hardly know what to reply.

From corresponding with and talking to Surveyors of many outports over a period of 15 years—even occasionally being present as they perform their acts of public relations—I know well what a vital role they fill. I know, too, of the support and leadership they give to their professional organisations. However, my paper was written for the Lloyd's Register Technical Association, the Surveyors themselves, and I did not dwell long on these matters for fear of boring my colleagues with what they must know better than anyone.

I regret extremely that anyone should have felt the outports had received insufficient recognition and I only hope that Mr. Atkins's impression was not widely shared.

Printed by Lloyd's Register of Shipping
at Garrett House, Manor Royal
Crawley, Sussex, RH10 2QN, England

Lloyd's Register Technical Association

DATA PROCESSING AT LLOYD'S REGISTER

A DESCRIPTION

A. J. Browne

Paper No. 3. Session 1972 - 73

Hon. Sec. C. Cummins
71, Fenchurch Street, London, EC3M 4BS

DATA PROCESSING AT LLOYD'S REGISTER

A DESCRIPTION

INTRODUCTION

The purpose of this paper is to set down some facts about data processing work already completed at Lloyd's Register, and some possibilities for work which is to be undertaken in the immediate future; consequently the paper is divided into two main sections.

In confining this paper to a discussion of data processing applications it has been necessary to distinguish between these and technical applications. Lloyd's Register's data processing activities can, for the purposes of this paper, be described as those which are not solved by means of mathematical computations: they therefore rely on techniques of data manipulation, data storage and data retrieval, in order to provide a data management service to the various departments of the Society. Examples of the precise applications of these techniques will be found throughout the pages of this paper.

In the section which deals with work already completed, it is not possible, because of the limitations of space, to give detailed descriptions of the various systems; in any case, the objective of the paper is to provide general indications of the scope of a system, rather than the minutiae of it. The same considerations exist in the section which deals with future projects. However, in the latter section, the Author does not wish to go to a level of detail which gives the impression that the problems have been solved, or that agreement has been reached on the emphasis to be placed on any aspects of a proposed system. Except for one of the proposed systems, feasibility studies have not been undertaken; no basic systems design work has therefore yet been done; no reports have been submitted either to the departments concerned or to Lloyd's Register's senior management. The section contains, therefore, general views of the likely ways in which work could develop, based on the current thinking of the departments concerned and of the data processing staff. There is at present no commitment and it is certainly true to say that the success of these projects will largely depend on the contribution of ideas from the staff at all levels of the various departments themelves.

Computer terminology is something of a problem: where-ever possible jargon has been avoided and the loosest possible meaning to some very specific computer terms has been given. This will not, it is hoped, give offence to any computer professionals who read the paper. Similarly, the absence of detail in the discussion of existing projects may have caused some gross over-simplifications; it is hoped those who are closely concerned with these projects will duly make allowances.

Data processing, and indeed computing in general at Lloyd's Register, is at something of a cross-roads. This is probably for two main reasons: first, because the Society has taken the steps to forsake small and medium size computers for a large machine, involving the learning of very different concepts; second, because of the impending use of major items of software, including packages for structural analysis and data base management.

However, there is every indication that the projects to be developed will provide the facilities which Lloyd's Register really wants. Unlike the circumstances in which some past projects have been developed, a good deal of detailed planning has been done for adequate resources to be available for future systems, in terms of hardware, software and manpower. These three subjects are covered in the paragraphs which follow.

HARDWARE

Some description of the type of hardware which Lloyd's Register is now using is necessary to an understanding of the scope of projected computer applications, since their design will be limited by the available hardware resources.

These resources have to be shared by both technical and data processing applications and the way in which this sharing is planned is the measure of the effective economic use of the total resource.

The general characteristics of the individual hardware components are described below: of these, it is the power of the central processing unit and the size of the memory which are mainly justified in terms of the requirements of technical rather than data processing applications, since it is the technical applications which demand high speeds and large areas of immediately accessible data for lengthy mathematical computations.

This equipment is housed in a specially designed computer centre, where there are good facilities for handling the projected increase in throughput and where there is good security to prevent unauthorized access to the computer complex.

(i) **Central Processing Unit**

The central processing unit is responsible for executing the instructions (such as ADD, SUBTRACT, etc.) contained within programs.

The present central processing unit has the power to process about 2 000 000 ADD instructions per second compared to about 280 000 instructions per second previously.

(ii) **Main Storage**

This is the memory of the computer. The main storage of the present computer is capable of holding 512 000 characters at any one time, twice that of the previous machine. This increased capacity means that it is possible to run two or more programs concurrently on the machine, in addition to holding a Control Program or Operating System which is always resident and which is responsible for supervising the overall running of the configuration. The programs which are being run on this configuration also reside (wholly or partially) in main storage while their instructions are being executed by the central processing unit. Further increases in main storage can be made as the need grows.

(iii) **Direct Access Storage Devices**

These devices are directly accessible by the computer and are principally used to hold files of data, both permanent and temporary. 400 000 000 characters of data can now be held at any one time. This is ten times that of the previous devices, which were able to hold the equivalent of the complete contents of the Register Book.

Moreover, the average access time to any item of data has been reduced from $\frac{1}{12}$ to $\frac{1}{30}$ of a second.

(iv) **Magnetic Tape Drives**

Four tape drives, capable of operating at speeds of 80 000 characters per second are attached to the present configuration. This compares with two drives on the previous computer, recording or retrieving data at speeds of around 30 000 characters per second. Magnetic tapes are principally used to hold files of data which do not need to be directly addressed by the computer.

(v) **Line Printers**

The line printers are used for printing reports, at speeds up to 1000 lines per minute. To increase printing capacity a second line printer was recently added.

(vi) **Card Handling Devices**

On the previous configuration, a reader/punch was used for reading 80 column cards at a speed of 400 cards per minute and for punching at 150 cards per minute.

To allow for increased capacity and to provide essential safeguards in case of failure of this component, two card readers are now installed each capable of reading 1000 cards per minute.

(vii) **Terminals**

Two main types of terminal are being considered for use in Lloyd's Register.

(a) Teletypewriters, which consist of a keyboard only, are slow devices and can be used for such purposes as program development, initiating jobs and for applications where there is a requirement for on-line computing with a relatively low volume of input and output.

(b) Visual display terminals, which consist of a keyboard and a display screen, can be used for on-line applications where a large volume of data has to be examined and can be presented in the desired format; this kind of terminal is suitable for use where the data to be input is lengthy and complex in structure.

Approximately eight teletypewriters are attached to the present configuration, on an experimental basis.

SOFTWARE

Software can be described as being a program or group of programs designed to assist the computer user, either in obtaining the maximum efficiency from the hardware, or in the performance of some specific but commonplace task.

The largest producers of software are, naturally, the computer manufacturers, although recently there has been a marked increase in the number of independent software producers.

Software can be grouped, rather generally, into a number of categories. These are mentioned briefly here.

(i) **Operating Sytems**

Operating systems exist to ensure the fullest utilisation of the resources available within a computer installation. There are two ways in which this can be achieved: first, by taking responsibility for the control and allocation of the available resources, thus reducing time-consuming operator intervention; secondly, by the efficient scheduling and mixing of the work-load.

Spooling is a development of scheduling and is becoming a more important function of major operating systems. It enables a number of jobs to be submitted to the computer at any time and the system then accepts responsibility for their eventual execution. The system will schedule the jobs, based on priorities allocated, and store any data associated with the jobs until it is required. As part of the running of jobs, it will store the output, choosing, again on given priorities, the most opportune time for the actual presentation of that output on the selected peripheral device.

Under an operating system of this kind, jobs can be handled either in batch or in on-line mode. Batch jobs will be run according to their priorities and as soon as the necessary hardware resources are available. Jobs accepted for on-line running will be handled straightaway, since the programs concerned will be resident in core storage and waiting for the job to be submitted.

(ii) **Application Packages**

Individual programs, or groups of programs, designed to perform commonplace tasks, e.g. sales forecasting, are often available for purchase or lease. These packages are usually designed to appeal to as wide a market as possible but may need modification for use within a specific environment.

(iii) **Utilities**

Computer manufacturers provide a large number of utility programs to help with the general running of a computer installation. Many utilities are concerned with the organizing of data on specific devices, the transcription of data from one device to another and the reporting of the contents of storage media, e.g. magnetic tapes and disks.

(iv) **Programming Languages**

A number of programming languages is normally available for use with a range of computer hardware. Some languages are more suited to particular types of applications than others. Most installations standardize on the use of one or two languages. Languages are either high-level or low-level. High-level languages are largely machine-independent, so that a program written in COBOL or FORTRAN can be run, with relatively minor modifications, on more than one manufacturer's hardware. Lloyd's Register at present uses COBOL for data processing and FORTRAN for technical computing. Low-level languages are normally machine-dependent and are closely associated with machine code, which is the level to which all languages are reduced by compilers before programs can be executed. Lloyd's Register uses an Assembler language, which is low-level, only when its greater precision and economy is particularly advantageous.

(v) **Data Base Management**

A data base can be described as a non-redundant collection of interrelated data items, accessible to any number of separate applications, but with a flexible construction which is entirely independent of any of the applications which may use it. Until now Lloyd's Register has designed data files to serve individual data processing applications, such as payroll, classification, sister ships, etc. Each file of data set up in this way has been allocated an identifiable area of storage on disc or magnetic tape and, generally speaking, it has remained the exclusive responsibility of the user to control the data which is available to him. The only example of a file which is shared by more than one user is the General Ship File, which forms

the basis of the classification system and which is also used for statistical analysis. Even here, however, there are very few items within a record which are accessed by both users.

Unlike Lloyd's Register, many companies have, over a period of years, developed separate computer systems, each with its own data files which may have contained large amounts of data needed by more than one system. This has inevitably led to the unnecessary duplication of data on more than one file. Data redundancy is not just wasteful in terms of storage space and of the additional routines which have to be made available to access it; it is dangerous because it can lead to inherent anomalies, incompatibilities and variations in format, and because it is extremely difficult to ensure that all duplicated items are updated in the same way and at the same time.

So far Lloyd's Register has developed computer systems with very little data which is common to more than one project: these projects have been classification, payroll and payroll costing, loans ledger, statistics, industrial services accounting and a technical records sister ships application.

The intention to develop a number of major computer systems over the next few years and the treatment of the Society's data as something much more than a number of overlapping sets, each set being handled exclusively by one department and one particular suite of computer programs, has been under active consideration for some time.

Lloyd's Register is therefore in a fortunate position, because

(a) it has available the raw materials for the creation of a data base,

(b) it is on the threshold of the development of a number of systems, all of which can make extensive use of a data base,

(c) it has implemented relatively few applications, the data for which would have to be reconstructed and absorbed into a data base,

(d) it has taken a policy decision to use data base techniques in the knowledge that there is software available to create, maintain and access the data base which it designs,

(e) for the first time, users will be able to achieve easy access to data via a user-oriented enquiry language.

A data base has one additional important feature. It has inbuilt security. Only authorized persons are permitted to have access to the data base and particular parts of it can be security-coded in order to restrict access to persons with the appropriate security status.

STAFF

Some indication of the increase in the data processing workload over the past three years may be given by the gradual increase in staff levels during this period. At the beginning of 1970 there were seven analysts and programmers: there are now 17, with four more to be recruited now to help with the proposed new systems.

Also during the past three years, there has been a strengthening of systems and programming management and a need has arisen for all production and development work to be co-ordinated before submission to computer operations.

In the area of computer operations, the increase in data processing work has been partly responsible for the extended use of data preparation and computer facilities. The size of the data preparation team has grown from four to nine and data control from one to three.

Three years ago the computer was used five days a week from 0800 hours to 2000 hours. At that time there were two operators. Now, in spite of the equipment upgrades, the use of the computer approaches 24 hours a day, with weekend work whenever necessary. The number of operators has increased to eight.

As a result of this recruitment, Lloyd's Register now has at its disposal a range of technical abilities in key areas of data processing skills. In particular, there is some useful knowledge of large machine utilization, multi-programming environments, teleprocessing, data base and management information systems, spooling, real-time, on-line and conversational programming.

CURRENT PROJECTS

Classification

The detailed design work on the Classification Computer System was begun towards the end of 1969, following a comprehensive survey of the requirements of Headquarters and Outports.

The main objectives were at that time seen to be

(a) to speed the flow of information from Headquarters both to Owners and to Outports,

(b) to exercise closer control over surveys,

(c) to increase the quantity and quality of statistical information.

A forerunner of the current classification system was a pilot scheme for 120 ships, which gave some useful guidelines in the compilation of a dictionary of surveyable machinery items, in the production and use of a quarterly statement for owners of survey work done or due to be done and in reporting by outports.

Classification computer information is stored on a series of interconnected files, each of which can be accessed via a General Ship File. This file contains the general information for each classed ship, including descriptive information and main survey dates which are subject to most frequent access. This file also contains statistical data for the world fleet. Other files which are dependent on the General Ship File include

(a) an Items file, whose records contain specific data relating to each surveyable item, including the item code and the date of the previous survey. Using a dictionary of items, components and descriptions, which is copyright to Lloyd's Register, an item code can be expanded to a full description for printing,

(b) a Name and Address File, which contains details which can be used to despatch all communications to owners or their managers and agents,

(c) an Annotated File, containing details of current survey returns and all survey reports received during the current period; it can be described as a file of work in progress and is used in the production of the Diary list which is referred to below.

(d) the SRL File, which contains alphabetic descriptions of conditions of class or other notes.

The current system has been designed round a strict timetable, in order to ensure that documents for punching received in Headquarters from outports reach Classification Department with the least possible delay and in order to meet the

workflow requirements of the manual system.

Interface between the operational computer system and the Classification Department is provided by a Data Control Unit, whose responsibility it is to control all input, monitor output and ensure accuracy of the data held on the computer files.

Apart from a discrepancy report which allows control of the resubmission of all rejected data, the system produces two main daily reports

(a) an annotated listing, showing new reports received, ships under survey, postponements requested, etc.,
(b) an updating list, showing details of all transactions handled, endorsements and fees.

A monthly listing (*see* Fig. 1) is sent to outports on microfilm.

Approximately 250 copies are produced from information supplied by Lloyd's Register in a magnetic tape formatted to the requirements of a specialist microfilm bureau: the bureau is also responsible for distribution. Outports are equipped with microfilm readers or, in some cases, microfilm reader/printers. The microfilm arrives in the form of one or more spools, arranged alphabetically by ship name. All outports are provided with a microfilm copy containing details for all ships; no attempt is made to send selected information to individual outports. For each classed ship, information is given relating to main survey dates, showing due or overdue surveys, surveys partly held or postponed and, in continuous survey cases, individual items falling due within the coming six months. Condition of class items from the SRL are also given. Hence, Surveyors are able to gain a complete and up-to-date picture of the survey status of any ship and to extract details before survey work is undertaken.

A statement (Fig. 2) with similar information to that which appears on the monthly microfilm, is sent to each owner, showing the position on the first working day of each quarter; in addition to a list of items falling due, the quarterly statement is to give owners adequate warning of survey work falling due, so that they can schedule their survey work. It is hoped that, as a result, more surveys will be held nearer their due dates.

The SRL book is printed each month from computer output; the pages are formatted from computer files and printed on special stationery, and from these pages plates are made and printing done by the Printing House.

While ships are still being added to the computer files, a microfilm (Fig. 3) is produced at the end of each quarter showing, for each ship, a complete list of surveyable items, with reporting codes. A copy of this microfilm is sent to each outport for reference purposes. Ultimately, the production of this microfilm may be undertaken at longer intervals (e.g. six-monthly or annually).

The Diary listing is produced each Wednesday, containing all cases where surveys are within a specified number of weeks of their due date, or are overdue; thereafter, these cases reappear on the Diary listing at predetermined intervals. Where necessary, survey reminder letters are also printed for despatch to owners.

The rules governing the inclusion of an item on the Diary review listing are particularly stringent and the objective of the Diary has been to give Classification Department Staff maximum control of survey status. However, the number of cases included in the Diary review has exceeded the original

```
XXXXXXXX                                          LR NO 6543210      GROSS TONS    10000    BUILT  03-66    DATE  1/ 4/70
                                                                   FLAG RURITANIA
                                   ***  EXPIRY DATES OF STATUTORY CERTIFICATES  ***
L/LINE 31/ 3/71               SAFCON 31/ 3/71                   SAF. EQ  1/ 1/72                     RADIO  3/ 2/71
                                          ***  MAIN SURVEY DATES & CONTROL  ***
HULL SPECIAL SURVEY (CSH) ASSIGNED 03-66 DUE 03-71             * ANNUAL LOADLINE              ASSIGNED 02-69 DUE 02-70 P/P 05-70 APP
ANNUAL CLASSIFICATION     ASSIGNED 02-69 DUE 02-70 P/P 05-70 APP * DOCKING                    ASSIGNED 09-68 DUE 09-70
NO.1 LOWER AUX. BOILER    ASSIGNED 02-70 DUE 02-72             * NO.2 UPPER AUX. BOILER       ASSIGNED 09-69 DUE 09-71
NO.1 EXHAUST GAS
 ECONOMISER               ASSIGNED 07-68 DUE 07-70 - - - - - - - - PARTLY HELD - ITEMS NOT SEEN
   1234 ADJUSTMENT OF SAFETY VALVES                            *
TAILSHAFT                 ASSIGNED 03-66 DUE 03-70 P/P 09-70 REQ * STEAMPIPES                 ASSIGNED 03-66 DUE 2NDSS
                                              ***  C.S.M. ITEMS OVERDUE  ***
2338 INLINE TRUNK ENGINE                                       * 2401 FORWARD SCAVENGE BLOWER                               DUE 02-70
   2345 NO.1 MAIN JOURNAL & BEARING                  DUE 12-69 * 2472 INTERMEDIATE SHAFTING                                 DUE 03-70
  2351 NO.2 MAIN JOURNAL & BEARING                   DUE 12-69 *
   2367 NO.3 MAIN JOURNAL & BEARING                  DUE 12-69 *
   2379 NO.4 MAIN JOURNAL & BEARING                  DUE 12-69 *
   2380 NO.5 MAIN JOURNAL & BEARING                  DUE 12-69 *
   2392 CRANKCASE DOORS & RELIEF DEVICES             DUE 01-70 *
                                        ***  C.S.M. ITEMS DUE IN NEXT 6 MONTHS  ***
2413 PUMPING ARRANGEMENTS                            DUE 06-70 * 2564 EXHAUST GAS ECONOMISER CIRCULATING PUMP               DUE 09-70
2456 PORT STEERING MACHINERY UNIT                    DUE 06-70 * 2580 SEA CONNECTIONS
2538 FORWARD SCAVENGE AIR COOLER                     DUE 06-70 *    2591 PORT SIDE SUCTIONS                                 DUE 09-70
2549 FORWARD MAIN FEED-PUMP                          DUE 06-70 *    2603 PORT SIDE DISCHARGES                               DUE 09-70
2552 AFTER MAIN FEED PUMP                            DUE 06-70 *
                                              ***  C.S.H. ITEMS OVERDUE  ***
5432 FORECASTLE DECK PLATING                         DUE 12-69 * 5483 NO.5 HOLD                                             DUE 02-70
5478 NO.3 HOLD                                       DUE 12-69 *
                                        ***  C.S.H. ITEMS DUE IN NEXT 6 MONTHS  ***
3217 NO.1 TWEENDECK SPACE                            DUE 06-70 * 3305 NO.4 CENTRE DOUBLE BOTTOM TANK
3229 UPPER TWEENDECK MIDSHIP SPACE                   DUE 07-70 *    3318 EXAMINATION                                        DUE 08-70
3234 O F BUNKER COFFERDAM                            DUE 07-70 *    3324 TEST                                               DUE 08-70
3247 AFT PEAK TANK                                             * 3335 ENGINE ROOM DOUBLE BOTTOM COFFERDAM                   DUE 09-70
   3256 EXAMINATION                                  DUE 08-70 * 3348 NO.7 DOUBLE BOTTOM COFFERDAM                          DUE 09-70
   3261 TEST                                         DUE 08-70 * 3357 STEERING GEAR                                         DUE 10-70
3279 NO.3 PORT F W DOUBLE BOTTOM TANK                          * 3362 BILGE SUCTIONS                                        DUE 10-70
   3283 EXAMINATION                                  DUE 08-70 * 3370 FIRE EQUIPMENT                                        DUE 10-70
   3297 TEST                                         DUE 08-70 *
                                             ***  CONDITIONS OF CLASS  ***
ALL ME GUIDE BAR SUPPORT PTF LOWER ENDS EXCEPT NO.3 TO BE RADIUSED + WELDED REPS BY 05/70
NO.2 (S.F) AND NO.5 (S.A) GUIDE BAR SUPPORT PTES (CRACKED) * BY 05/70
UPPER HALF OF ME NO.4 CRANKPIN BEARG (BROKEN WHITE METAL) * BY 07/70
```

FIG. 1

Quarterly Listing — **LLOYD'S REGISTER OF SHIPPING** — PAGE 1

LR. NO.	SHIP'S NAME	GROSS TONS	DATE OF BUILD	FLAG
XXXXXXX	XXXXXXXXX	XXXXX	XXXXX	XXXXXXXXX

EXPIRY DATES OF STATUTORY CERTIFICATES

LOADLINE	30/ 6/70
SAFCON	30/ 6/70
SAFETY EQUIP.	1/ 1/72
SAFETY RADIO	3/ 2/71

A.N. OTHER SHIPPING COMPANY LTD.,
MARINE BUILDING,
MAIN STREET,
CITY,
COUNTRY.

MAIN SURVEY DATES AND CONTROL	ASSIGNED DATE	DUE DATE	O/DUE	POSTPONEMENT NEW DATE	DUE NEXT 6 MONTHS
CONTINUOUS SURVEY HULL	12-64	12-69	YES	06-70 APPROVED	
CONTINUOUS SURVEY MACHINERY	12-64	12-69	YES	06-70 APPROVED	
PERIODICAL LOADLINE INSP.	25/ 2/69				
ANNUAL CLASSIFICATION	02-69	02-70	YES	06-70 APPROVED	
DOCKING	06-68	06-70			YES
NO.1 LOWER AUX. BOILER	02-70	02-72			
NO.2 UPPER AUX. BOILER	09-69	09-71			
NO.1 EXHAUST GAS ECONOMISER PARTLY HELD - ITEMS SEEN - INT. & EXT. EXAM. WITH MOUNTINGS & SAFETY VALVES	07-68	07-70			YES
TAILSHAFT	12-68	12-72			
STEAMPIPES	12-64	12-69	YES	06-70 APPROVED	

CONTINUOUS MACHINERY SURVEY CONTROL

*** ITEMS SEEN SINCE LAST LIST ***	DATE
INLINE TRUNK ENGINE	
NO.6 CYL,COVER,PISTON,CONN ROD & BEARING,VALVES & GEARS	03-70
STARBOARD INBOARD S.W. COOLING PUMP	02-70
DIESEL OIL TRANSFER PUMP	03-70
EMERGENCY AIR COMPRESSOR SAFETY DEVICES & ENGINE	03-70
OUTBOARD MAIN ENGINE F W COOLER	02-70
PORT INBOARD AUX ENGINE IN ENTIRETY	02-70

*** ITEMS OVERDUE ***	DUE DATE
INLINE TRUNK ENGINE	
NO.1 MAIN JOURNAL AND BEARING (P/P APPROVED 06-70)	12-69
NO.2 MAIN JOURNAL AND BEARING (P/P APPROVED 06-70)	12-69
NO.3 MAIN JOURNAL AND BEARING (P/P APPROVED 06-70)	12-69
NO.4 MAIN JOURNAL AND BEARING (P/P APPROVED 06-70)	12-69
NO.5 MAIN JOURNAL AND BEARING (P/P APPROVED 06-70)	12-69
CRANKCASE DOORS & RELIEF DEVICES (P/P APPROVED 06-70)	01-70
FORWARD SCAVENGE BLOWER (P/P APPROVED 06-70)	02-70
INTERMEDIATE SHAFTING (P/P APPROVED 06-70)	03-70

*** ITEMS DUE IN NEXT 6 MONTHS ***	TO BE EXAMINED BY
PUMPING ARRANGEMENTS	06-70
PORT STEERING MACHINERY UNIT	06-70
FORWARD SCAVENGE AIR COOLER	06-70
FORWARD AUX FEED PUMP	06-70
AFTER AUX FEED PUMP	06-70

CONTINUOUS HULL SURVEY CONTROL

*** ITEMS SEEN SINCE LAST LIST ***	DATE
NO.1 HOLD	02-70
ENGINE ROOM	03-70

*** ITEMS OVERDUE ***	DUE DATE
FORECASTLE DECK PLATING (P/P APPROVED 04-70)	12-69
NO.3 HOLD (P/P APPROVED 06-70)	12-69
NO.5 HOLD	02-70

*** ITEMS DUE IN NEXT 6 MONTHS ***	TO BE EXAMINED BY
NO.1 TWEENDECK SPACE	06-70
UPPER TWEENDECK MID-SHIP SPACE	07-70
NO.3 LOWER TWEENDECK SPACE	07-70
NO.3 UPPER TWEENDECK SPACE	07-70
AFT PEAK TANK	08-70

CONTINUED

Quarterly Listing — **LLOYD'S REGISTER OF SHIPPING** — PAGE 2

LR. NO.	SHIP'S NAME	GROSS TONS	DATE OF BUILD	FLAG
XXXXXXX	XXXXXXXXX	XXXXX	XXXXX	XXXXXXXXX

CONTINUOUS MACHINERY SURVEY CONTROL

*** ITEMS DUE IN NEXT 6 MONTHS ***	TO BE EXAMINED BY
EXHAUST GAS ECONOMISER CIRCULATING PUMP	09-70
SEA CONNECTIONS	
PORT SIDE SUCTIONS	09-70
PORT SIDE DISCHARGES	09-70

CONTINUOUS HULL SURVEY CONTROL

*** ITEMS DUE IN NEXT 6 MONTHS ***	TO BE EXAMINED BY
NO.3 PORT F W DOUBLE BOTTOM TANK TEST	08-70
NO.4 CENTRE DOUBLE BOTTOM TANK TEST	08-70
STEERING GEAR COMPARTMENT	09-70
STEERING GEAR	09-70
NO.1 PORT DEEP TANK	09-70
NO.1 STARBOARD DEEP TANK	09-70

CONDITIONS OF CLASS (SEE KEY)

01 ALL ME GUIDE BAR SUPPORT PTE LOWER ENDS EXCEPT NO.3 TO BE RADIUSED + WELDED REPS BY 05/70
02 NO.2 (S.F.) AND NO.5 (S.A.) GUIDE BAR SUPPORT PTES (CRACKED) * BY 05/70
03 UPPER HALF OF ME NO.4 CRANKPIN BEARG (BROKEN WHITE METAL) * BY 07/70

END OF LISTING

FIG. 2

```
XXXXXXXX                       LR NO 6543210      GROSS TONS      1000      BUILT 03-66      DATE  1/ 1/70
                                                      FLAG RURITANIA
                                  *** SURVEYABLE ITEMS - MACHINERY ***
C017 INLINE TRUNK ENGINE
   0024 NO.1. CYL,COVER,PISTON,CONN ROD AND BEARING,VALVES AND
        GEARS
   0031 NO.2. CYL,COVER,PISTON,CONN ROD AND BEARING,VALVES AND
        GEARS
   0048 NO.3. CYL,COVER,PISTON,CONN ROD AND BEARING,VALVES AND
        GEARS
   0055 NO.4. CYL,COVER,PISTON,CONN ROD AND BEARING,VALVES AND
        GEARS
   0062 NO.5. CYL,COVER,PISTON,CONN ROD AND BEARING,VALVES AND
        GEARS
   0079 NO.6. CYL,COVER,PISTON,CONN ROD AND BEARING,VALVES AND
        GEARS
   0086 NO.7. CYL,COVER,PISTON,CONN ROD AND BEARING,VALVES AND
        GEARS
   0093 NO.1. CRANKPIN,BEARING AND WEBS
   0105 NO.2. CRANKPIN,BEARING AND WEBS
   0112 NO.3. CRANKPIN,BEARING AND WEBS
   0129 NO.4. CRANKPIN,BEARING AND WEBS
   0136 NO.5. CRANKPIN,BEARING AND WEBS
   0143 NO.6. CRANKPIN,BEARING AND WEBS
   0150 NO.7. CRANKPIN,BEARING AND WEBS
   0167 NO.1. MAIN JOURNAL AND BEARING
   0174 NO.2. MAIN JOURNAL AND BEARING
   0181 NO.3. MAIN JOURNAL AND BEARING
   0198 NO.4. MAIN JOURNAL AND BEARING
   0200 NO.5. MAIN JOURNAL AND BEARING
   0217 NO.6. MAIN JOURNAL AND BEARING
   0224 NO.7. MAIN JOURNAL AND BEARING
   0231 NO.8. MAIN JOURNAL AND BEARING
   0248 NO.1. FUEL INJECTION PUMP
   0255 NO.2. FUEL INJECTION PUMP
   0262 NO.3. FUEL INJECTION PUMP
   0279 NO.4. FUEL INJECTION PUMP
   0286 NO.5. FUEL INJECTION PUMP
   0293 NO.6. FUEL INJECTION PUMP
   0305 NO.7. FUEL INJECTION PUMP
   0312 CRANKCASE DOORS AND RELIEF DEVICES
   0329 SCAVENGE RELIEF DEVICES
   0336 TV DAMPER OR DETUNER
   0343 CAMSHAFT/S DRIVE
   0350 HOLDING DOWN BOLTS AND CHOCKS
   0367 ENGINE TRIAL
0374 SUPERCHARGER
0381 INTERMEDIATE SHAFTING
   0398 NO.1. INTERMEDIATE SHAFT
0400 PUMPING ARRANGEMENTS
   0417 BILGE AND BALLAST LINES AND FITTINGS
   0424 PIPING SYSTEMS, FITTINGS AND CONTROLS EXCL BILGE AND
        BALLAST
   0431 WORKING TEST OF BILGE SYSTEM,INCLUDING EMERGENCY SUCTION

* 0448 PORT STEERING MACHINERY UNIT
* 0455 STARBOARD STEERING MACHINERY UNIT
* 0462 WINDLASS MACHINERY
* 0479 SPARE GEAR,MACHINERY AND ELECTRICAL
* 0486 ELECTRIC AIR COMPRESSOR AND SAFETY DEVICES
* 0493 AUX DIESEL AIR COMPRESSOR AND SAFETY DEVICES
* 0505 UPPER AIR RECEIVER AND SAFETY DEVICES
* 0512 LOWER AIR RECEIVER AND SAFETY DEVICES
* 0529 STARTING AIR PIPES
* 0536 FIRST START ARRANGEMENT TRIAL
* 0543 F W COOLER
* 0550 L.O. COOLER
* 0567 PORT M.E.ATTACHED L.O. PUMP
* 0574 STARBOARD M.E.ATTACHED L.O. PUMP
* 0581 BILGE G.S. STARBOARD PUMP
* 0598 OILY BILGE HAND PUMP
* 0600 BALLAST STANDBY S.W. STARBOARD PUMP
* 0617 S.W. CIRCULATING PORT PUMP
* 0624 F W CIRCULATING PUMP
* 0631 STANDBY L.O. PUMP
* 0648 O.F. ELECTRIC TRANSFER PUMP
* 0655 O.F. TRANSFER HAND PUMP
* 0662 EMERGENCY FIRE FORECASTLE PUMP
* 0679 D.O. PORT OIL FUEL TANK
* 0686 D.O. STARBOARD OIL FUEL TANK
* 0693 GAS OIL OIL FUEL TANK
* 0705 EMERGENCY GENERATOR OIL FUEL TANK
* 0712 PORT AUX ENGINE
* 0729 STARBOARD AUX ENGINE
* 0736 UPPER AUX ENGINE
* 0743 ELECTRICAL EQUIPMENT
* 0750 SEA CONNECTIONS
*      0767 PORT SIDE SUCTIONS
*      0774 PORT SIDE DISCHARGES
*      0781 STBD SIDE SUCTIONS
*      0798 STBD SIDE DISCHARGES
* 0862 TAILSHAFT SURVEY
*      0879 APPROVED OIL GLAND
*      0886 CRACK DETECTION OF SCREWSHAFT CONE
*      0893 PROPELLER
*      0905 TAILSHAFT
*      0912 STERNBUSH

                                  *** SURVEYABLE ITEMS - HULL ***
1003 THICKNESS DETERMINATION
1010 SHELL PLATING
1034 PLATING ETC. IN WAY OF SHELL OPENINGS
1041 STERNFRAME
1058 RUDDER
1065 RUDDER TRUNK
1072 BRIDGE SUPERSTRUCTURES
XXXXXXXX                    LR NO 6543210  (LIST DATE  1/ 1/70)
1089 FORECASTLE DECK PLATING
1096 UPPER DECK PLATING
1105 HOLD/S
   1115 NO.1. HOLD
   1122 NO.2. HOLD
1139 TWEENDECK SPACE/S
   1146 NO.1. TWEENDECK SPACE
   1153 NO.2. TWEENDECK SPACE
1160 FORECASTLE TWEEN DECK SPACE
1177 ENGINE ROOM TWEEN DECK SPACE
1184 AFT TWEEN DECK CREW SPACE
1191 ENGINE ROOM
1203 CHAIN LOCKER
1210 FORWARD PEAK TANK
   1227 EXAMINATION
   1234 TEST
1241 ENGINE ROOM STARBOARD GAS OIL TANK
   1258 EXAMINATION
   1265 TEST
1272 ENGINE ROOM PORT UNDERDECK F W TANK
   1289 EXAMINATION
   1296 TEST
1308 ENGINE ROOM STARBOARD UNDERDECK F W TANK
   1315 EXAMINATION
   1322 TEST
1339 AFT PEAK TANK
   1346 EXAMINATION
   1353 TEST
1360 NO.1. DOUBLE BOTTOM TANK
   1377 EXAMINATION
   1384 TEST

* 1391 NO.2. DOUBLE BOTTOM TANK
*      1403 EXAMINATION
*      1410 TEST
* 1427 NO.2. STARBOARD DOUBLE BOTTOM TANK
*      1434 EXAMINATION
*      1441 TEST
* 1458 NO.3. PORT O.F. DOUBLE BOTTOM TANK
*      1465 EXAMINATION
*      1472 TEST
* 1489 NO.3. STARBOARD O.F. DOUBLE BOTTOM TANK
*      1496 EXAMINATION
*      1508 TEST
* 1515 ENGINE ROOM PORT L.O. DRAIN TANK
*      1522 EXAMINATION
*      1539 TEST
* 1546 UNDER ENGINES
* 1553 STEERING GEAR COMPARTMENT
* 1560 WINDLASS
* 1577 ANCHORS
* 1584 CABLES
* 1591 STEERING GEAR
* 1603 AUX STEERING GEAR
* 1610 HAND PUMP/S
* 1634 SOUNDING PIPES AND DOUBLINGS UNDER
* 1641 AIR PIPE/S
* 1658 MAST/S
* 1665 RIGGING
* 1672 FIRE EQUIPMENT
* 1689 MEANS OF ESCAPE
*      1696 MACHINERY SPACE
*      1708 CREW AND PASSENGER SPACES
*      1715 SPACES IN WHICH CREW EMPLOYED
* 1722 COMMUNICATION - BRIDGE TO ENGINE ROOM
* 1739 COMMUNICATION - BRIDGE TO ALTERNATIVE STEERING POS,N
* 1746 HELM INDICATOR
* 1753 PROTECTION OF AFT STEERING WHEEL AND GEAR
```

FIG. 3

estimates, and there may be a requirement to modify the basis on which the Diary is produced in order to allow more efficient manual control of those cases which warrant close attention.

Classification Sub-system

A sub-system exists to form the basis for collecting together classification information about each ship and preparing it for inclusion in the main system.

A complete list of surveyable items for each ship is created on a holding file by means of a "pull-card" system. Punched cards containing dictionary definitions can be selected and after computer processing, can be recirculated into the pull-card system. Item codes are automatically allocated and master lists, for placing on board ship in special folders, are printed. So far approximately 9875 ships out of a total of 10 500 have reached this stage. Both before and after a ship has been transferred to the main classification system, the list of surveyable items can be amended.

A "cutover" procedure is followed to make final preparations for a ship to be included in the main system. This consists principally in applying dates and postponement information to main surveys and individual items. The system monitors each ship to ensure that a complete set of information is present. Since December 1971 approximately 300 ships have been cutover each month. The total number of completed ships is therefore 3860. In order to bring forward the date by which this operation will be finished, the number of ships handled each month has recently been increased to 420.

Payrolls and Payroll Costing

The current payroll system came into existence at the time of decimalization in February 1971, following a deicison that it was not a practical or economic proposition to attempt to modify the programs that were then in use. In addition there were good reasons for designing a new system, which could respond to changed costing requirements, which could provide an essential interface with a small Visible Record Computer (VRC) which was to handle the production of the weekly and foreign payroll and which could look forward to other accounting systems to be linked with the payroll and costing programs. For all these reasons, therefore, it was decided to design a system which would be specific to Lloyd's Register's requirements rather than to purchase and to have, presumably, to make extensive modifications to a generalized payroll package.

The present system can perform a number of functions, of which the following are the most important

(a) payment of monthly U.K. salaries,
(b) payment of pensions,
(c) preparation of credit transfers for foreign staff,
(d) costing reports for weekly, monthly and foreign staff, and for pensioners,
(e) periodic reports and returns,
(f) Loans Ledger accounting.

The system allows for amendments to be made to payroll and loans information at any time in the four weeks prior to actual payroll production and a series of control reports provides analyses of the effects of all changes to monetary fields.

The system calculates gross and net pay, as well as P.A.Y.E. tax and State Graduated pension, taking into account loans, allowances and deductions and accumulating totals.

Details for a number of periodical reports and returns (Tax, National Insurance, B.U.P.A., etc.) are available for extraction from the computer files. Other information, common to most payroll systems, is also available for reference purposes; this includes Bank codes, National Insurance rates and tax tables.

Payroll information for weekly and foreign staff is accepted into the main computer system from the VRC via punched cards, primarily for costing purposes.

The Loans Ledger is maintained separately from the payroll system, but is referenced at the time that net pay is being calculated. The Loans Ledger sub-system can produce detailed statements for the current year, together with the balance outstanding. Audit certificates can also be produced, for sending to all personnel with loans, for them to sign and return.

In the early design stages of the system, it was decided, as a matter of policy, to restrict the amount of personal data which is held on the various computer files. For this reason, the number of reports which can be requested is small; there is a periodical analysis of staff by department and grade, and some of the preliminary tabulations in connection with salary reviews can be produced.

The Computer bureau, together with the Staff Manager and the Chief Accountant, are all actively concerned to ensure that access to computer payroll and personal data is made only in conditions of adequate security.

The various facilities described here have been made available progressively since February 1971 and there are now more than 50 programs in the system.

Statistics

Nineteen sixty-eight was the first year in which statistical tables were produced from computer-held information. Since then the format, quality and quantity of the statistical data has improved, and all the programs have been rewritten. The statistical tables were first produced, using the current system, in 1970. Most of the tables which are produced find their way into the published Statistical Tables for the year, having first been reformatted, condensed, adjusted and supplemented by Statistics Department.

Thirty-four tables were produced in 1971: 17 tables were published. Approximately 30 000 pages were printed, and the published tables consisted of just over 60 pages. The work of extracting, sorting, editing and printing the tables took just over 30 hours of computer time.

Throughout the year and especially at the time when the computer files are being finalised for table production in July/August, the quality of the data can be proved by preliminary runs of specific tables or by the use of a generalized search program, which has been developed especially for use by Lloyd's Register on these files. This program can also be run in order to satisfy the requests of Lloyd's Register's senior management, other departments, or outside sources. The use of the program is controlled entirely by Statistics Department, who are able to specify parameters to cause the program to carry out the searches required. Single requests or multiple requests are possible; in the latter case, the statistical information on the General Ship File is scanned once and all relevant data is extracted for subsequent sorting and printing. The generalized search program is able to present its results as a fully detailed tabulation with totals, as a partial listing with totals, or in the form of totals only. An example is shown at Fig. 4.

```
REQUEST NO 01            STATISTICS MASTER FILE AS AT 28.05.1972        INCORPORATING BATCH 999               PAGE  1
                *** FC ***
              SHIPS NAME                    FLG  LGT     HGT      DWT  LRC    CHA         A    B      C     DCB     COB              BATCH
    LR
                         LEN   BRD  DGH MAT SCR  INT STA STB   SHD      PAS         REF     PRP FUL     HSP         SPD CNV    ALT
-----------------------------------------------------------------------------------------------------------------------------------
           SAINT MATTHEW                    113          0   474      950  0                HR            1943-00  328               105
500514 6
                         184R   33   12  1   1    9  50       OSD        0                  12  0     900BHP   10/2  01
-----------------------------------------------------------------------------------------------------------------------------------
           PATI                             113          0   5623    9640  1  1   +100A1    XX            1950-12  001                 0
500644 9
                         457    58   25  1   1    9  50       OSD        0                  11  0    3300BHP   13/0  00
-----------------------------------------------------------------------------------------------------------------------------------
           ANTONIOS                         113          0   1832    2767  3                BV            1938-08  274                96
500949 1
                         310    41   19  1   1    9  50       OSD        0                   1  1    1250IHP   11/0  00
-----------------------------------------------------------------------------------------------------------------------------------
           CAROLINE                         113       1646   2716    3996  0                GL            1954-00  277                77
501035 9
                         288R   45   17  1   1    9  50       OSD/CSD    0                  15  0    2400BHP   12/2  00   01-00-00
-----------------------------------------------------------------------------------------------------------------------------------
           FTEOKLIS                         113          0   5573    9300  1  1   +100A1    XX            1937-08  277               104
501082 8
                         451    58   24  1   1    9  50       OSD        0                  11  0    3300BHP   11/2  00
-----------------------------------------------------------------------------------------------------------------------------------
           ALDA                             113          0   7292    9480  0                BV            1942-00  303                96
501108 0
                         476    60   25  1   1    9  50       OSD       12  REF   53000     11  0    4400BHP   13/0  00
-----------------------------------------------------------------------------------------------------------------------------------
           KIMOLOS B                        113          0   3858    6020  1  4   100A1     XX            1948-00  323                72
501195 1
                         338    50   23  1   1    9  50       CSD        0  REF    8660     11  0    1700BHP   10/0  00
-----------------------------------------------------------------------------------------------------------------------------------
           DIMITRAKIS                       113          0   1863    3220  1  1   +100A1    XX            1955-11  321               144
501210 1
                         328    44   18  1   1    9  50       OSD        0                  11  0    2550BHP   14/1  00
-----------------------------------------------------------------------------------------------------------------------------------
           ALFA                             113          0   7388    8856  0                BV            1941-00  303                 7
501226 6
                         476    60   25  1   1    9  50       OSD       12  REF   85190     11  0    4400BHP   13/2  00   05-00-00
-----------------------------------------------------------------------------------------------------------------------------------
           ARCHIGETIS                       113          0   8076   12003  1  1   +100A1    XX            1952-09  303                 6
501536 1
                         472    60   28  1   1    9  50       CSD        0                  11  0    4200BHP   11/2  00
-----------------------------------------------------------------------------------------------------------------------------------
           ELPIDA                           113          0   8382   12457  3                BV            1956-07  303               101
501538 5
                         478    61   28  1   1    9  50       CSD        0                  11  0    4200BHP   12/2  00
-----------------------------------------------------------------------------------------------------------------------------------
           CRETAN HOPE                      113          0   1860    2721  0                NV            1947-00  305                55
501547 6
                         277    41   17  1   1    9  50       OSD        0                   1  1    1150IHP   11/0  00
-----------------------------------------------------------------------------------------------------------------------------------
```

FIG. 4

At present both the data and the search program continue to be constraints upon the quality of the statistical service which can be offered by means of computer processing. Occasionally, it is possible to write programs to meet special requests for information, but more frequently it is found necessary to state that the work cannot be undertaken.

FUTURE PROJECTS

Technical Records

The aim of the computer system, on which work is well advanced, is to assist Technical Records Department to maintain a complex organized collection of data (technical particulars and defect information) to which reference can be made by Head Office departments, outports and the shipping industry at large.

The Department began with some distinct advantages, since a punched card system has been in use for some time; technical particulars (basic data) are already held from 1960 onwards on approximately 85 000 cards and details of hull and machinery defects and damages for the same period on approximately 72 000 cards. The defects and damage file is growing at a rate of more than 400 cards a week.

The main system aim is to allow the statistical examination of numbers and types of defects, with reference to all relevant basic data, in order to show the varying effects of the factors involved and the probable consequence of removal of any of the contributory elements. The ideal system should therefore allow the automatic monitoring of trends in defects and the early reporting of all significant variations of pattern for more extensive analysis.

As a first step, a system is being made available to allow extensive analysis of basic data and defect information, using a specially designed enquiry language. It is clearly not possible to write a series of programs to represent the wide range of enquiries which are needed. The enquiry language offers considerable flexibility, although the enquirer must know the full implications of each enquiry which he wishes to make and must specify the extent of his enquiry with great accuracy. Details of frequently-used enquiries can be retained within the system and recalled automatically. For the moment, therefore,

```
QUERY TRODBASE 'CRACKS IN TANKS,HOLDS,DECKS OF 67-8 BULK CARRIERS;
# OVER 30,000GT';
WHEN SHIPTYPE EQ 200,230 AND GRTONS GE 30;
FOR EACH HDEFECT;
WHEN CMPRTMNT EQ 01,02,04,20 AND DEFECT EQ 04,05;
LIST LRNO, SHIPNAME, YRBUILD, YRDFCT, GRTONS, CMPRTMNT, CAUSE, REPAIR;
END PROCEDURE;
```

Fig. 5

```
**** GIS FP LOCAL OUTPUT      ZPPLL001 ****

CRACKS IN TANKS,HOLDS,DECKS OF 67-8 BULK CARRIERS OVER 30,000GT
01  LRNUMBER  SHIPS-NAME                                   YRBUILD  YRDFCT  GROSS-TONS  COMPARTMENT  CAUSE  REPAIR
01   670665   GRAFTON                                        67       68      :43          20          50     07
01   670785   FERNIE                                         67       69      :42          20          99     03
01   671221   LEISE MAERSK                                   67       70      :44          20          50     03
01   671666   GALLIC BRIDGE                                  67       70      :42          20          50     02
01   681138   NANNY                                          68       71      :44          20          99     02
01   682668   HAR SAGGI                                      68       71      :41          20          50     03
END OF DATA
```

Fig. 6

the initiative remains with the enquirer. Figure 5 gives an example of the use of the enquiry language to extract details of a defect in specified types of ship, using test data. Figure 6 shows the tabulation which results from such an enquiry.

The system is, naturally, only as good as the quality of the data which is available to it. In the case of data relating to defects and damages, a number of facts must be known; these include the causes, the location, the type of repair and the circumstances of the incident, all of which are converted to computer code, based on a coding structure. It is clear, therefore, that a great deal depends on the quality of the report received from the Surveyor in the field.

Apart from the quality of the data collected, important decisions of policy have to be taken concerning the inclusion or exclusion of each item of data from the computer system. In this respect, statistics which are automatically compiled by the system relating to the use of data in the data base can be used. Items which are never, or infrequently, referenced may be excluded or replaced by new items.

Investigations fall broadly into three categories

(a) those which result from a specific request for information from a technical department, or from Senior Management, or from a source outside the Society,

(b) those which are mounted as part of Technical Records Department's program of regular and systematic scanning of known trouble areas and the defects which relate to those areas,

(c) those which are originated by Technical Records Department in order to monitor and audit the quality of the data in the data base.

The analysis of basic data and of defects and damage is to be handled by the generalized enquiry program in batch mode, since it is not considered necessary at this stage to make an on-line facility available.

There are a number of significant benefits to be derived from the new system. These include

(a) more rapid and more comprehensive analysis,

(b) an improved ability to detect trends,

(c) the provision of a new and improved service in response to requests for information.

Register Book

The current manual system consists of the collection of information mainly from external sources but supplemented by data passed from other departments and outports; in particular, from Classification. Register Book Department is responsible for the amending of Register Book entries, and for additions to New Entries and the Cumulative Supplement. Copy for the next edition of the Register is prepared in the form of hand-written annotations to the previous Register and this is sent to Printing House for composition in accordance with an agreed schedule. The first segments are sent at the end of November, and the process continues until the beginning of May, in time for publication in July. The proofs are read and, when agreed with RB Department, printed. The cycle time for composition, proof-reading, adding late information and printing a segment is two and a half weeks. Once a segment has been printed, it will be reset only when there is an appreciable number of amendments. Amendments which do not cause a segment to be reset are included in the first Supplement, which appears with the Register Book.

There are facilities at the Printing House for the storage of standing type and so it is possible to amend parts of the previous year's Register Book. A significant proportion of entries in the Register remain unaltered from one year to the next.

It has been estimated that there are in the region of 8000 segment amendments in a year, 3000 new ships and 3000 changes of name.

It has been considered for some time that there might be ways in which a computer system could assist in Register Book production and related services. One of the principal advantages in a computer typesetting solution must be the shortening of the length of time taken to produce the Register from the point when the first segment is sent to the Printing House, now in late November. It is generally agreed that the Register Book contains a considerable quantity of information which is out-of-date. Computer typesetting will ease this problem, but the Register Book, if it retains its present form, will still have to be read in conjunction with a Supplement.

A second significant improvement might be achieved in the area of updating the Register. Apart from the fact that there would no longer be a need for proof-reading at the printing stage, it should be possible to provide a quick and convenient means of searching for an existing entry and displaying it for examination in order to see if and how it has to be amended. The editing of the entry into an acceptable format must be an important consideration.

The third improvement is likely to come in the quality of data and its compatibility with other data which at present is maintained separately. In particular, there is some considerable overlap in the data handled by Register Book, Statistics, Technical Records and Classification, and a comprehensive survey of these requirements should lead to the removal of inconsistencies and duplication. In this connection, the advantages offered by data-base techniques are discussed elsewhere in this paper.

The last important advantage to be mentioned here is the increased availability of Register Book information which will result from the proposed computer system, both for use by other systems and by direct interrogation. Although, as part of the initial system, this facility may only be available in batch mode, the most significant improvement in the general availability of information throughout the Society and outside, will come when it is possible to interrogate this data base using on-line terminals.

The systems design must provide effective solutions to a number of basic problems. Among these are

(a) the conversion problem. How is the conversion to a computer system best organized? Is it best handled gradually, over a period of time, or should the whole of the work be concentrated into a relatively short period? What resources are available? Is outside help a reasonable proposition?

(b) the problem of proving the new system and the accuracy of the converted data. What kind of time-table will have to be drawn up to give adequate safeguards? How long can staff be expected to operate two systems in parallel, if at all? How should the proving be done? At what point of the annual cycle should conversion start and finish?

(c) the updating procedures. Should there be terminals at which updating is done? What kind of terminals? How many? What requirements are there for hard copy print-out of transactions, for audit and proof-reading purposes?

It looks as if the basic elements of the system may consist of computer files to which it is possible to apply transactions directly, using some kind of on-line visual display terminal, on which additions and amendments to the files can be set up and validated. This method would allow visual checking of the complete entry after amendment and this would be the only proof-reading necessary. Clearly, it will have to be possible for easy examination of any entry already on the computer files, so that the user can feel confident that he has complete control over all Register Book information. From here, it is a comparatively short step to the provision of a wider service, in order to meet the needs of other departments who require access to the latest Register Book information.

The typesetting procedure itself will presumably consist of the extraction and format-editing of data on to magnetic tape or disk files, for further detailed formatting by a specialist computer-typesetting organization in order to satisfy the particular technical requirements of the equipment which they use.

This approach will make it quite simple for the extraction of specific categories of data in order to produce specialised directories. For example, there might be specialised directories for tankers, container ships, bulk carriers, fishing vessels, general cargo ships, or ships grouped by age or flag.

STATISTICS

Developments to the Statistics project are likely to be of two kinds: improvements to existing facilities and the undertaking of new areas of work.

In the improvement to existing facilities, it is considered that the analysis and retrieval of statistical information is capable of very considerable development. The restrictions associated with the present amount of statistical data held and the methods available for retrieval have been mentioned elsewhere in this paper. The present construction of the data makes extensions to the number of items of data virtually impossible and the search facility is not powerful.

The main purpose in improving this service is to be able to respond to a growing demand for statistical searches. At present, many requests involve the interrogation of computer-held data which has to be supplemented by manually provided data and other requests have to be handled entirely by manual processes. Each request for information has to be scrutinized by Statistics Department first in order to establish whether the information is available and then to estimate the time and manpower required to prepare the answer. On this basis, a significant proportion of requests has to be declined.

It is likely that, for most enquiries, assistance by Statistics Department will continue to be necessary in the construction of search parameters; only the most straightforward requests for specific items of information would require no monitoring or specialized assistance.

Statistics Department will probably also have to define the extent of each request in order to determine whether a request can be handled using the on-line facilities, or whether it should be submitted for batch processing; enquiries involving lengthy file handling operations, except those with a sufficiently high priority, would be scheduled for running in batch mode outside the prime shift.

In the area of completely new work, it seems likely that data will be collected of three main types

(a) general statistics, based on the statistical information at present held on the General Ship File, but entirely reshaped and greatly extended,

(b) casualty information, to be created from historical records, and available among other things for the compilation of the quarterly and annual casualty returns,

(c) new construction data, which would be the basis for a large number of reports, including
   (i) merchant ships launched, and produced annually,
   (ii) shipbuilding return, produced quarterly,
   (iii) new orders, produced weekly,
   (iv) building schedule for classed ships, produced monthly,
   (v) management information statements, produced monthly and annually,
   (vi) periodical reports to management on topical subjects,
   (vii) short-term forecasting.

These files of information will be updated daily (or in some cases at less frequent intervals) from the outport returns, supplemented by data collected from their sources.

The principal objective of the new system must be to provide the speedier and more reliable handling of statistical enquiries, with provision for sophisticated statistical analysis of data as well as for the more routine searches which result in a tabulation or a series of totals. Although it is most unlikely that the on-line updating of statistical files could be justified during these next stages of development, it seems reasonable that the creation of a much more comprehensive statistical data base will lead to the use of on-line data retrieval techniques, especially since data controlled by Statistics Department will be supplemented at least by Register Book, Technical Records and Classification data.

ACCOUNTS

The overall objective in developing this project will be to create an integrated accounting system, with one part of the project assembling data and feeding it automatically to another part. For example, it should be possible for payroll information to be fed, via payroll costing, into the system which compiles port operating statements.

Various aspects of an integrated accounting system are mentioned here. However, the order of implementation is not yet decided and the extent of development will depend largely on the results of the initial systems studies.

(i) Budgetary Control of Salaries

Based on the current payroll system and the associated costing routines, a system for budgetary analysis and control of salaries and wages is likely to be developed. This system will allow for budget estimates to be inserted at the beginning of the period and for budget amendments to be handled thereafter. Data from the payroll system, as well as additional information originating from Headquarters or outports, will be processed against the budget, giving comparisons throughout the budget period.

(ii) Pension Funds

The computer system is likely to handle the posting of pension contributions to and payments from the appropriate fund. The current payroll system already maintains records of pension contributions for the current fiscal year and for the current Lloyd's year. The control of contributions can therefore be made from these details and the existing manual records of each contributor can be replaced by computer-generated tabulations or record cards.

On the payments side, pensions paid in currency can be controlled by an addition to the pension payments facilities which are part of the current system. From this file of pension information, details of contributions to be repaid to leavers can be made available.

At present a triennial valuation of the Funds and other actuarial information is derived from the manual records, supplemented by a special questionnaire completed by each contributor. Through the computer system, it will be possible to produce reports and to perform actuarial calculations by applying calculation parameters, referencing personal and payroll information as necessary.

(iii) Income and Expenditure

An income and expenditure system is dependent on the receipt of data from a variety of sources; some of the most important sources are the accounting returns submitted quarterly by outports, details of cash payments, the debit books, salaries and wages, port transfers and budgetary information.

Some, if not all, of this data can come from other parts of an integrated accounting system: for example, payroll and invoicing information can be passed from their respective sub-systems and postings can be made directly to a Ports Accounts file and a General Ledger file. The end-products of the system would probably include a series of reports connected with Port Accounting (port journals and port operating statements) and periodic statements of the Society's income and expenditure. Two further important aspects of the system would be the capability to produce comparisons, by cost centre between actual expenditure and the budget, and a range of management accounting reports.

(iv) Invoicing

Depending upon further investigation of volumes and the quantity of descriptive matter to be included on the invoices, an invoicing system may be devised which will produce invoices as part of the main computer system or which will receive input data which has been punched from invoices which have been prepared, as at present, on standard typewriters.

The punching of cash receipt information can be from remittance vouchers and may reach the computer system via the Visible Record Computer.

The system will have to provide a satisfactory solution to the problem of matching inadequately documented payments to the original invoices and it is most likely that clerical expertise will continue to be relied on.

There are a number of valuable reports which the system could produce, including a list of unallocated fees, analyses of receipts, a list of unpaid fees, lists of outstanding invoices by age, customer statements, reminder letters, fee analyses and advices of payments received on behalf of outports. Perhaps the most important feature would be the automatic posting of invoice data and of payments received to the main Income and Expenditure system.

CLASSIFICATION

Work which may be undertaken in connection with the Classification computer system can be looked upon as an extension to the present system rather than the development of new areas.

One of the disadvantages of having to apply all transactions in batch mode is that the complete process may have to be

divided into three separate activities, with inevitable duplication of effort; the current state of the record in the computer file may have to be proved before the details of the transaction can be formulated, the transaction has to be coded and punched, and the results of computer processing may have to be checked. For many types of amendment, including reports and returns received from outports, existing batch processing methods are undoubtedly the most suitable; but for other types of updating, especially some of those which originate in Classification Department, an on-line updating facility may represent a real improvement. In the case of amendments to survey dates, statutory certificate renewals, postponements, SRL data, names and addresses, the data could itself be visually checked on a terminal screen and could be examined in the context of other data relating to the same ship.

Currently, there is no easy facility for the examination of all classification data relating to a particular ship, no analysis is possible by type of ship, by survey status, etc., nor is correlation of classification data with data from other systems possible.

For information which is not readily available from other sources (e.g. microfilm or copies of owners' quarterly listings), it is desirable to provide easy on-line access to a wide range of computer-held classification data, to be displayed at a terminal in a format which is easy to read. By this means, queries from Classification Department as well as those from management and owners, could readily be answered. Details relating to the list of surveyable items, survey date of individual items, postponements, addresses and survey cycle times could be provided, often without reference to the ship's folder.

FEE SCALES

New Construction Estimates

There is a procedure at present for the recording on edge-punched cards of new construction work, including details of shipyard, type of ship or yacht, scope of Surveyor activity and fees charged. From this file, estimates can be based on comparable past constructions. This system works well, as records can be accessed quickly in response to requests for information. The main advantage of a computer system would be the availability of a wider range of information, in addition to edge-punched card data (which would have to be transferred to a computer file). This would include the new constructions file, also used in the Statistics system, and details of fee income and Surveyors' time, attributable to ships under construction, which would be by-products of classification reporting. Satisfactory solutions would have to be found to the need to provide estimates at very short notice, although 48 hours' warning of requirements is often given.

Fee Scales Analysis

It is considered that analyses of computer files could provide a series of reports to aid management to review and set Fee Scales. These might include

(a) Periodical Surveys
- (i) analysis of fee income,
- (ii) analysis of ships subject to periodical survey, by age, dimensions, tonnage, horsepower, etc.;

(b) New constructions
- (i) analysis of fee income (for the current year and for previous years),
- (ii) analysis of ships at present under construction,
- (iii) analysis of the L.R. share of the World Order Book,
- (iv) analysis of the historical new construction file.

New construction income could be projected for the coming year, using both current and proposed Fee Scales in terms of the L.R. share of the World Order Book in addition to ships currently under construction. From this information, the expected income and the impacts of possible fee scale changes upon various outports and types of business could be assessed.

CONCLUSION

The foregoing sections of this paper have been an attempt to present a situation report on data processing work at Lloyd's Register. The concluding section provides an opportunity to speculate on the ways in which data processing in the Society may develop in the next few years. The justification for such work will, it is hoped, never simply be one of business expediency. The aims of Lloyd's Register's computer development will be surely, not only to provide a service which it has not before been able to offer or which it finds it can offer no longer, but also be able to free staff from those duties which are not rewarding or stimulating, so that they can undertake duties which are. It is right, therefore, to see people as the first and most important consideration.

Shipping Information Bureau

After the next stage of computer systems development, the Society will have a large volume of accurate data on computer files, available for reference and analysis by its own staff which it can make available to outside subscribers. It is believed that there will be some considerable pressure on Lloyd's Register to offer this service and that, in offering it, the quality and scope of the data will become even more impressive. It is foreseen that it will consist of a number of terminals with direct access to a service which can call upon a range of computer files in order to satisfy the particular requirement. The service will be able to analyse and interpret the requirement, make decisions about the security aspects of the data to be referenced and go some way towards ensuring that the subscriber is obtaining the information which he really wants and that he is getting an answer which is complete. The system will be able to calculate a charge based, perhaps, on the complexity of the enquiry as well as its urgency, the data it has referenced, and the computer time used. It should be able to give an estimate before the work is undertaken.

A natural extension to this service would be a co-operative undertaking with other organizations with data which is complementary to our own, in order to provide a joint information service with much wider implications.

Problem Solving

It seems inevitable that there will be a change of emphasis, within the next few years, in the way in which data processing applications are approached. The concept of a tailor-made system developed by systems analysts and programmers will start to disappear, to be replaced by a series of powerful facilities which can be used direct by the user, in conjunction with a terminal.

The user will have, at his command, a language which will enable him to get data in and out of the computer, instead of having to wait for a lengthy period of system development and then be forced to go on making do with a system until it can be amended, modified or re-written.

In place of data processing staff who write problem-solving programs, therefore, will be a team whose job will be to administer and organize data, to ensure its complete availability to all who wish to access it.

The effect of this development would be to place the complete control of the system in the hands of the user and to allow him the flexibility to change his requirement with the minimum of effort.

Hardware Resources

Most systems are constrained by one kind of hardware limitation or another. Either the processor is too slow, or there is not enough main storage, or there is no computer time when it is required. There are limitations of this kind even at the moment when one changes to a much larger configuration. At present, very few computer installations are set up so that they can talk to one another in a network. I believe it will shortly be possible for a job to be submitted to a computer and for that computer to define exactly what resources are needed to perform the work. The work will then be passed to and carried out by whatever computer in the network is capable of satisfying all the requirements and any output will automatically be made available either at the source of the work, or at any other specified point in the network. The network would in time be world-wide. It is to be hoped that all at Lloyd's Register will be able to take good advantage of any advances in computer technology which may be forthcoming.

Printed by Lloyd's Register of Shipping at Garrett House, Manor Royal, Crawley, Sussex, RH10 2QN, England

Lloyd's Register Technical Association

THE PRINTING HOUSE

E. W. Rowell

Paper No. 4. Session 1972 - 73

Hon. Sec. C. Cummins
71, Fenchurch Street, London, EC3M 4BS

THE PRINTING HOUSE

History

Owing to the growing complexity of the Society's printing requirements the Committee decided, in 1889, to build its own Printing House in Southwark on the south side of the Thames, and in 1891 the Register Book, Appendix and Yacht Register were printed for the first time by the Society at its new establishment.

In this building accommodation was also found for the "Posters", who, continuously from 1775 until the present day, have kept the "Posted" copies of the Register Book up to date by hand correction in type.

Prior to 1891 the "Posting" of the Register Books was carried out at Headquarters at White Lion Court, Cornhill, and all printing work was done by outside organisations.

Printing for the Society continued without interruption until April, 1941, when the Southwark Street premises were badly damaged by enemy action.

This occurred at the height of the reprinting of the Register Book, about 20 per cent of the Register Book standing type being destroyed, and both the Composing Room and the Posting Department were completely gutted. The Posting Department was immediately transferred to the Head Office and alternative accommodation was found for the Composing Room. Notwithstanding the great amount of re-setting of the Register required, the new book was ready for publication two months after its due date.

The building was subsequently repaired, but the Society was denied the use of the top floor of the adjacent building which had formerly been leased, as that building had been destroyed beyond repair.

As soon as the war was over, steps were taken to obtain possession of the site adjacent to the old building, with a view to possible extension of the Printing House. Preliminary plans were drawn up, but it was found that the additional accommodation was too limited, particularly having regard to the expense which would have been involved in constructing and marrying a new building to the old Printing House.

In these circumstances it was decided to look elsewhere for accommodation, but one of the difficulties arising out of a change of locality for the Printing House was the desirability of retaining the staff, and in consequence consideration was given to one of the New Towns within reasonably easy reach of London where housing was made available to the staffs of all industrial concerns moving from the London area.

Visits were paid to Stevenage, Harlow and Crawley, and after a careful examination of all the implications, it was considered that a site in the Industrial Area of Crawley New Town would be most suitable. Early in 1951, therefore, negotiations were entered into with the Crawley Development Corporation, and it was decided to lease for 99 years a site of about two acres facing on Manor Royal, the main thoroughfare of the Industrial Estate.

Building commenced in January, 1953, and by August, 1953, it was possible to transfer the Composing Room, Reading Room, Monotype and Intertype Departments to Crawley.

Completion of the Machine Room and Warehouse rapidly followed, and by the end of 1953 the whole of the Printing Departments were installed and in operation. The Posting Department followed in February, 1954, and by the end of that month the Administrative Department of the Printing House had taken over their quarters.

The total staff of the Printing House at that time was some 120 persons, and this figure has remained constant to the present day, in spite of a tremendous increase in the production of printed matter.

Organisation

The printing departments at Crawley, as distinct from the "Posting" department, comprise the Composing Room, where type is set (with which is included the Reading Room and Casting Department), the Machine Room where the printing is carried out, and the Warehouse, where the work is folded, collated, stitched, cut and despatched.

Method of Printing

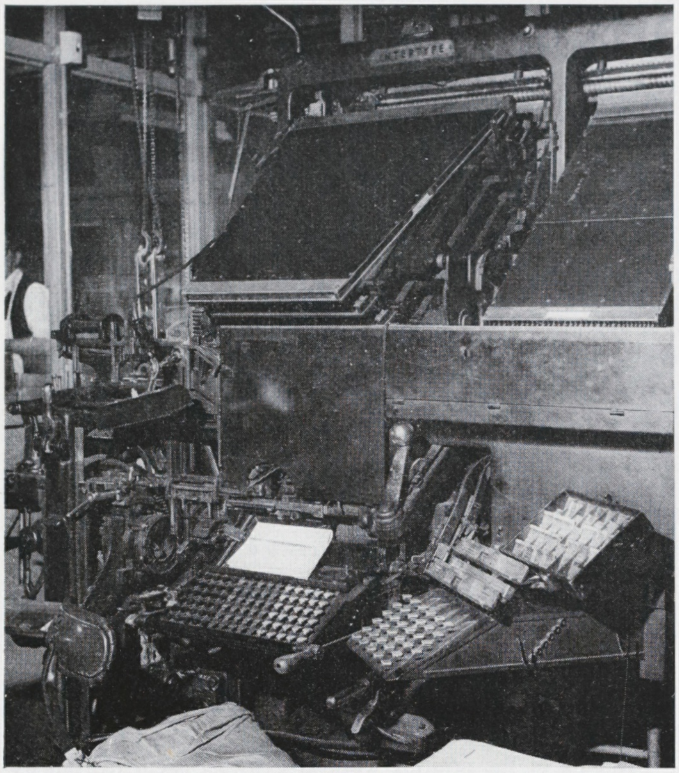
The bulk of the printing work at Crawley is carried out by the method known as "letterpress", or "typographic printing". Both of these terms strictly refer to the use of movable type, but neither covers the printing of illustrations. A more exact term is perhaps "relief printing", which is inclusive of both type and illustrations, implying only that the raised surface of the image carrier actually prints.

Additional to the letterpress work we have a camera and a small lithographic printing machine, on which the printed image is transferred to paper by means of a photographically produced metal or paper plate, having first been "offset" on to a printing roller.

The Composing Room

With the exception of the main publications of the Society, i.e. the Register Book, List of Owners, Appendix and Yacht Register, all of which have their own set time tables, every item produced at the Printing House has its printing order. This is a consecutively numbered docket bearing the title of the job, its size, the number of copies required, their ultimate destination and the paper to be used.

It has been asked on several occasions why it is necessary to know the number to be printed before the proof stage of a job is reached, and the answer lies in the necessity to ensure that the correct amount of paper is available, and also, in the case of our ever increasing colour work, of obtaining in advance the necessary quantities of the various coloured inks. Another reason, if the length of run warrants it, is to make provision for duplicate setting of type or the making of duplicate plates. Once in the Composing Room a job is set by one of two methods of mechanical composition—Intertype or Monotype. Two Intertype machines are available, the operating principles of which are very similar to the Lintoype machines used extensively in newspaper production. These Intertype machines set *and cast,* a line of type in one operation, the line



An Intertype machine

A Monotype keyboard

or "slug" having been moulded from a row of brass matrices assembled by a keyboard operator.

The Monotype system consists of keyboards for the type-setting which output punched holes in reels of paper, the reels being then transferred to the casting department where they actuate a number of casting machines which by an ingenious and complicated system of cams and rocker arms (worked by compressed air and electric motors) correctly position a pump nozzle over the selected matrix in a die case and force the metal through to cast the individual letters of type. This concentrated movement occupies only a matter of seconds and columns of type stream steadily from the casters. As each character is separate and can therefore easily be altered for correction or up-dating purposes, this system is more flexible than the Intertype process, where a solid line has to be re-set if any correction is required.

It may perhaps be of interest to mention here the essential requirements for an alloy to be used in producing type:—

1. It should melt at a comparatively low temperature.
2. It should cast easily and there should be no tendency to clog small apertures in mouthpieces and nozzles.
3. It should give a sharp casting correct in form and dimension when cold.
4. Type cast from the metal should be sufficiently hard and strong to withstand distortion under pressure and to resist abrasion during the process of printing.

The only range of alloys which satisfies these requirements and at the same time is reasonable in cost is that founded on lead as the basis, with additions of tin and antimony adjusted to the purpose for which the metal is required.

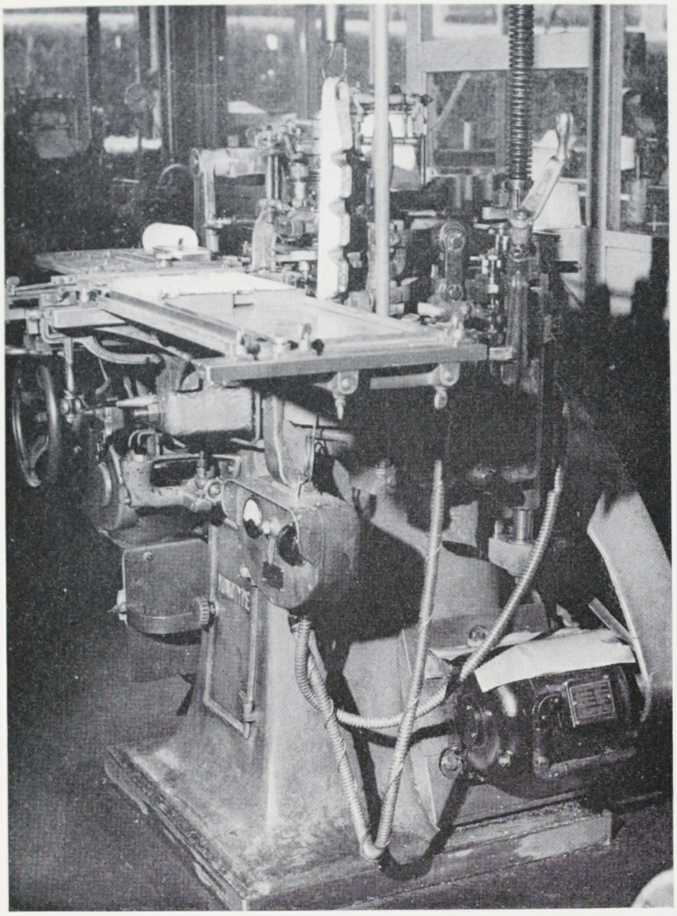
The conditions for casting "slugs" or lines of type on the Intertype machines demand a metal which will solidify quickly, and alloys with 11 to 12 per cent of antimony, 3 to 4 per cent of tin are generally used for this purpose. These alloys are necessarily softer than other printing metals.

In the case of monotype composition, however, type with improved surface hardness and wear resistance is obtained by using higher tin and antimony contents such as 8 to 13 per cent tin with 13 to 16 per cent antimony. Such alloys can be cast at high speeds in everyday conditions.

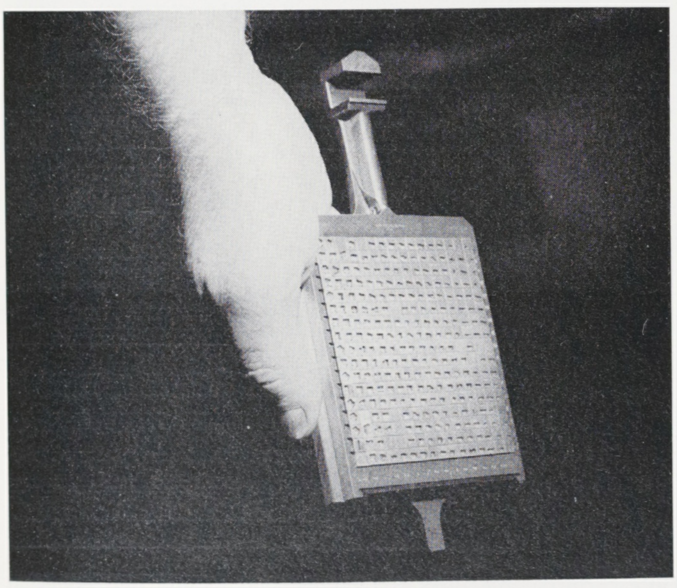
The alloy which is used at Crawley for Intertype work is 4 per cent tin with 11 per cent antimony, while for monotype casting two metals are available—one containing 13 per cent tin with 17 per cent antimony for small characters such as are used in the Register Book and Supplements, and the other 10 per cent tin and 16 per cent antimony for the slightly larger type of the Rules and Annual Report.

To return to our job—having been set, the type is then transferred to the main composing area where on one of the metal imposing surfaces—known as "stones" because they were once made of this material—it is assembled on "galleys" (metal trays) into columns which are either proofed in this form and issued as "galley proofs" or made up into page form from which proofs are taken to be returned to authors for scrutiny.

When the type has been assembled into the required form, the galley or page proofs are passed to the Reading Department where they are closely examined for typographical or other errors before being sent to Headquarters for the additional checking of technical details and for a small number (it is hoped) of last minute alterations.



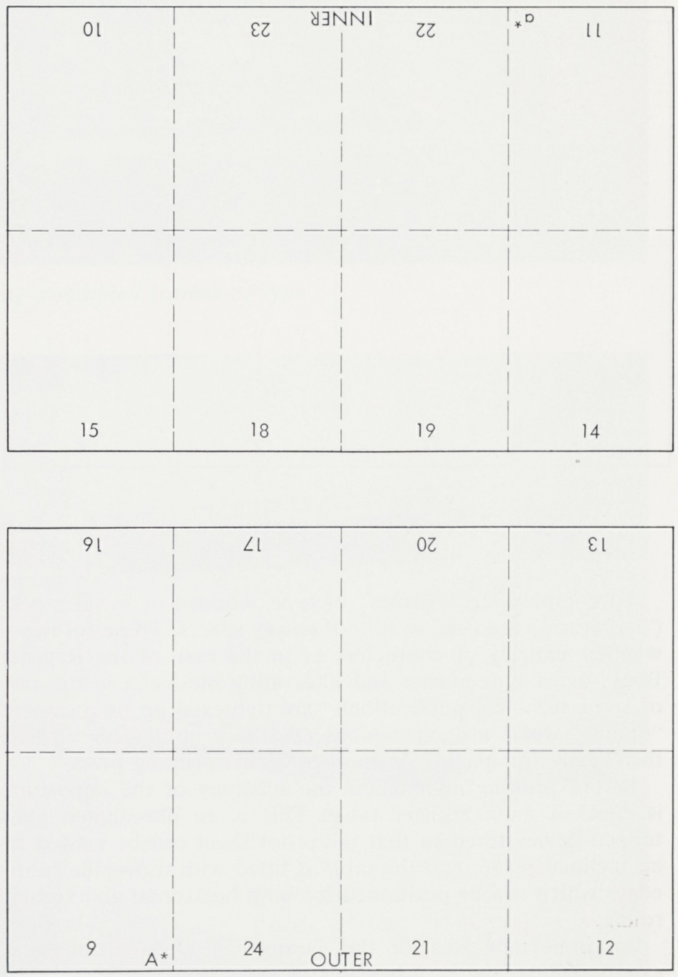
A Monotype casting machine



A Monotype die case

When the proofs are received back from the author the necessary corrections are made and the pages are assembled —"imposed"—on the metal imposing surfaces. Imposition is the method by which pages are arranged and locked-up within rigid metal frames known as "chases", so that when printed and the sheets folded and trimmed, the pages will appear in the correct order. The term "imposition" is said to have originated from the continual use of the expression "in position" employed in conjunction with the proper placing of pages on a sheet of paper.

The Register Book, for example, consists mainly of 32-page sections, each made up of a 16-page "star" signature inserted in a surrounding 16-page signature as in the following illustrations: —



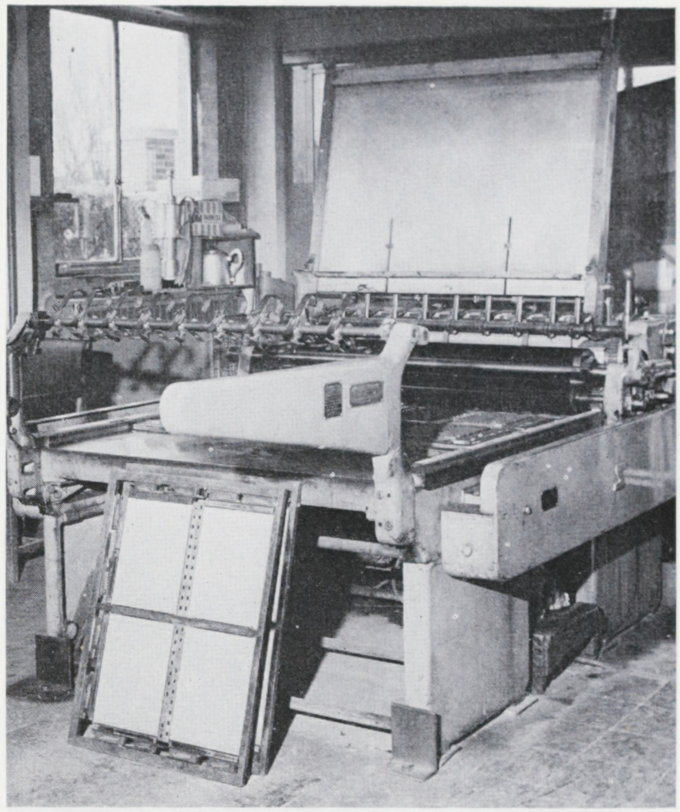
The "star" signature

The surrounding signature

To complete the "formes" of type, wooden or metal blocks ("furniture") are used to fill out empty spaces. These formes—whether entirely of characters as in the case of the Register Book, or of type matter and illustrating blocks as in the case of some technical publications—are tightened up by means of "quoins" which are expandable metal lock-up devices, and are then ready for placing on the bed of the printing press.

Before printing commences the accuracy of the imposition is checked on a register table. This is an illuminated glass topped device tilted so that the proof sheet can be viewed on an inclined plane, and the table is fitted with moveable ruling edges which can be positioned for both horizontal and vertical ruling.

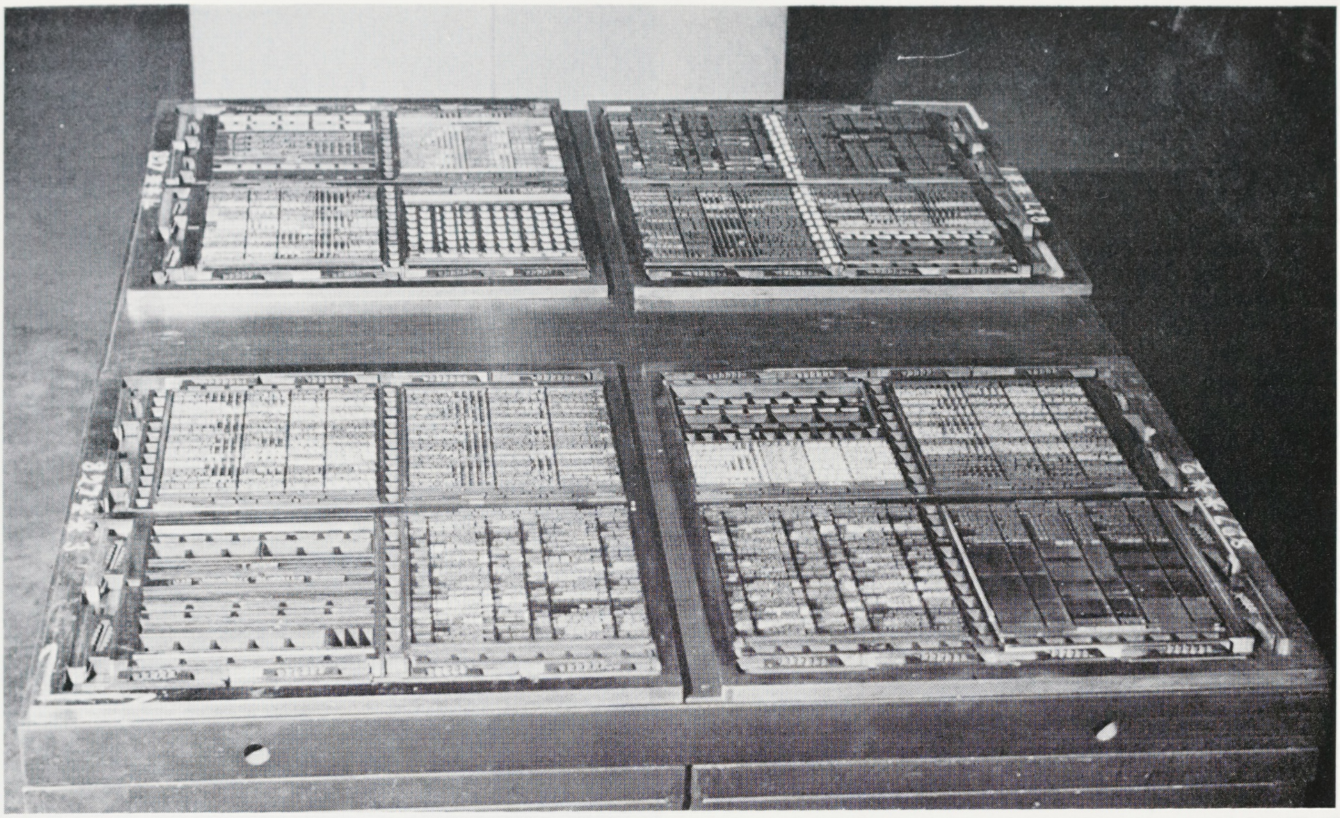
An important area of the Composing Department is an extensive type store. Advocates of litho printing make great play of the fact that photographic reproductions occupy so much less space than type metal and this is, of course, very true, but it has little significance in relation to the operations at Crawley, as the building was designed to house the necessary "standing type" which is kept from year to year in the case of all the up-dated publications.



The main proofing press

The reading room

The latest addition to the Composing Room is a small area housing a Kodak Platemaster camera. Here the paper plates are made from which are printed the monthly Special Reasons List, using a reduction of 57 per cent in size of the output sheet from the computer in Headquarters. By this reduction it is possible to produce two pages on one plate and the small litho printing machine at Crawley will handle two plates at one time, thus enabling four pages of the publication to be printed in one operation on one side of the sheet of paper.



A metal imposing surface, showing assembled formes of type

"Standing type", boxed and in chase, in a section of the type store

The Machine Room

With the exception of the one small litho machine already mentioned, all the printing presses are letterpress machines which print from a flat bed of type.

The Printing House has three large "Perfector" machines which will print up to a type area of $30\frac{1}{2}'' \times 42''$ on both sides of the paper in one operation. These are used mainly for the production of the bookwork and of the monthly supplement to the Register Book. There are also three two-colour machines which will print up to an area of $29'' \times 42''$ in two separate colours on the same side of the sheet in one operation, and one single-colour machine printing up to $30'' \times 42''$ on one side of the sheet.

In addition to these seven large machines there are two Heidelberg presses capable of producing the finest precision colour work up to an area of $21'' \times 28''$, and two other machines used for smaller jobbing work.

There are four operations in the functioning of letterpress printing machines. These are: —

1. Positioning the stock (paper) to receive the impression,
2. Inking the printing image carrier,
3. Transferring the ink from the image carrier to the stock to make the impression,
4. Removing the printed paper.

These four operations are represented by four units of the printing presses, viz.: —

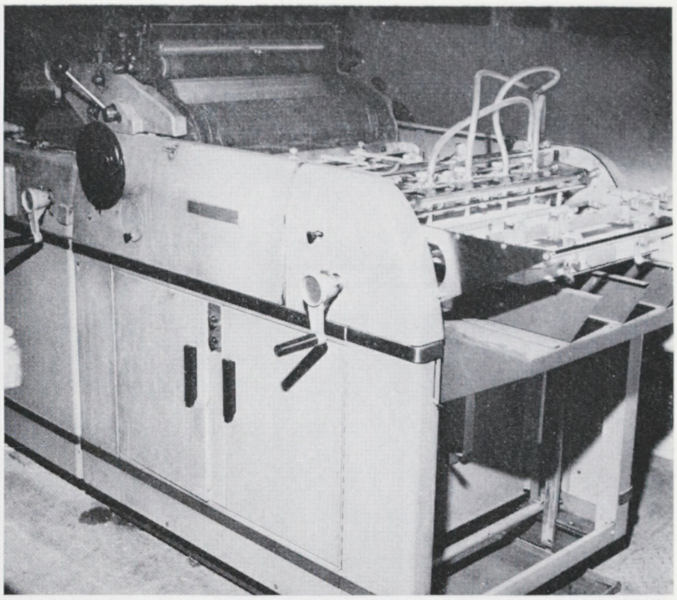
1. The feeding unit.
2. The inking unit.
3. The printing unit.
4. The delivery unit.

The corrected forme of type when ready for press is collected from the Composing Room by the machine assistant and placed on the bed of the printing press in a position favourable both to the press and the feeder, then fastened securely in position. A proof is taken by the machine and passed to the Reading Room for final checking, and "patching up" is carried out before the printing operation is undertaken.

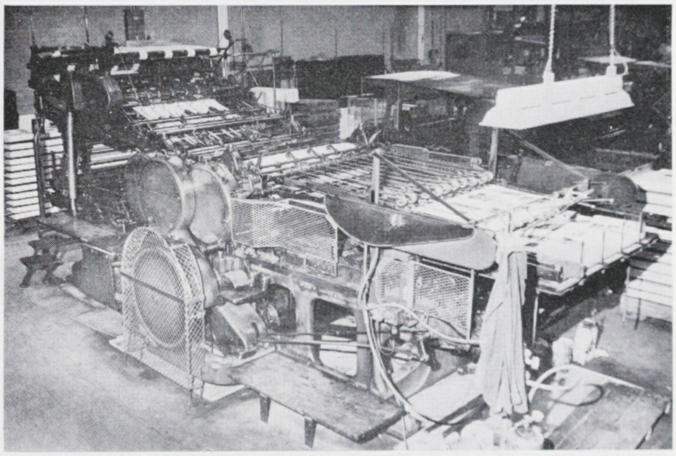
The height-to-paper measurement of type in this country is 0·918 in., and it is to produce this uniform height of type that all the pre-printing "make ready" operations take place, all of them calling for a high degree of skill on the part of the machine manager.

Three sheets of paper are passed through the machine together and the extra thickness of the paper produces the effect of a relief impression of the type on the top sheet. This impression sheet is turned face downward on an inclined board, and the machine manager uses small pieces of tissue paper to patch up the areas of type which are not so prominent as others. He carrries out this patching operation over the whole of the back of the sheet, thus equalising the differences between high and low type. Even with a forme of completely new type some "patching up" may be necessary, and the majority of bookwork calls for a great deal of this type of adjustment, as old and new type are continually being used in the same publication.

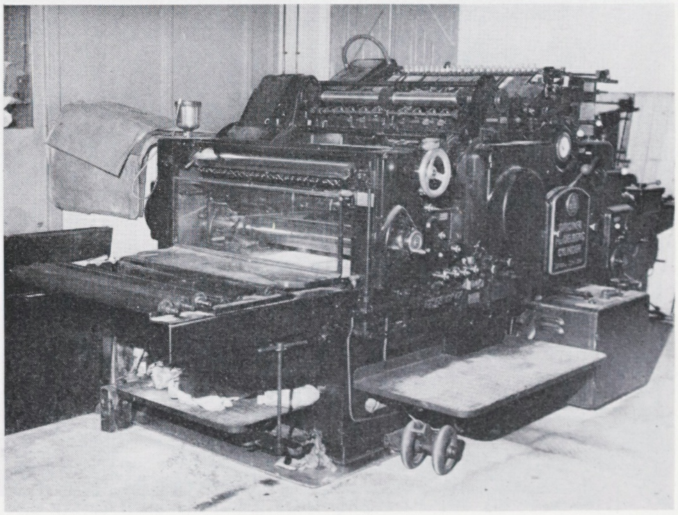
The patched up sheet is then fastened round the cylinder of the printing machine so that the correct impression is produced on the paper as it passes over the type bed and receives the printed image.



The small offset litho machine



A two-colour printing press



A Heidelberg printing press

"Patching up"

Paper is normally placed on the feeding unit of the machine and delivered to the press mechanically, but it is sometimes necessary for the paper to be fed by hand and this is a skilled operation performed by the machine assistants, although in the trade generally nowadays it is something of a dying art.

Another considerable skill is that used in the printing of half-tone blocks, both in black and the four-colour work produced for the Annual Report and for many brochures. Photographs and similar originals are transferred to the printed page by means of these half-tone blocks which consist of a series of dots of varying size, as is evident if the printed photograph is viewed through a magnifying glass. The range of screens in use varies from 55 dots to the square inch to upwards of 175 dots, according to the varying grades of paper on which the blocks are to be printed. The finer the screen, the better the quality of paper needed, thus 45 to 85 is used for newsprint, 100 to 120 for super-calendered printing, imitation art and matt art, and 133 to 150 upwards for fine art, cast coated art board, etc.

A half-tone illustration can be broken down into four main tones; solids, middle tones, light greys and highlights, and to obtain the best results when printing it is necessary to use an "overlay" on the cylinder of the machine. The effect of this overlay is to obtain different pressures on the different parts of the block, thus the darker areas will be blacker due to extra pressure and more ink, and the lighter areas will be cleaner due to less pressure and less ink.

To achieve a correct rendering of the tones mentioned above a three-ply overlay is normally satisfactory. To make this three-ply overlay a pull is taken on a sheet of coated paper to show the detail, and further pulls are made on three sheets of suitable overlay paper, normally super-calendered printing.

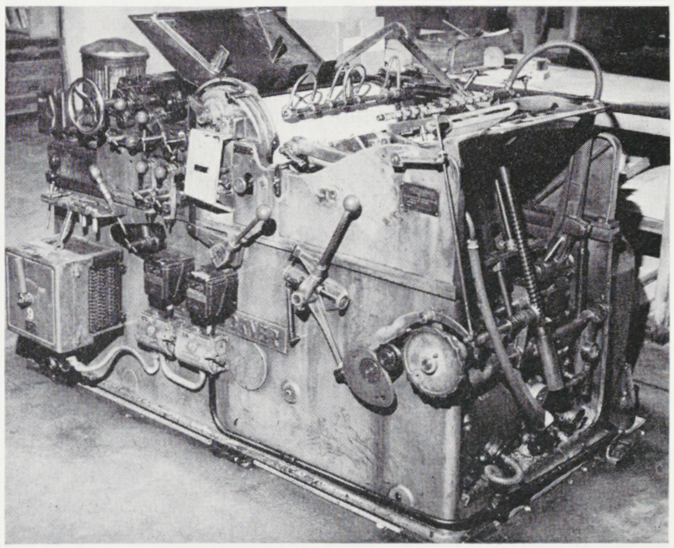
Then: —

1. On sheet 1 the highlights are cut away and discarded.
2. On sheet 2 the solids are cut out and pasted on to sheet 1.
3. On sheet 3 the solids and middle tones are cut out and pasted on to sheet 1.

This overlay must then be positioned very accurately on the cylinder of the machine, to produce the desired extra impression to the selected areas of the block.

Overlays also are now produced at the Printing House by mechanical means using what is known as the Primaton method. This is made from two different powders—a white plastic powder to prepare the relief and a blue heat-resistant powder to act as a filling medium and for cleaning the highlights. A proof is taken and immersed in a tray of the white powder which adheres to the ink in proportion to the gradations in tone of the illustration. The powder is then brushed off with a soft brush until it leaves the highlights. The proof is then drawn through a tray of blue powder which because of its finer grain settles between the white grains. Brushing is again necessary to clear the powder from the lighter areas. The overlay is completed by the application of heat, which fuses the powder in relief on the surface of the paper.

Colour blocks are so made that when printed one on the other in a given sequence the result will be a colour print bearing an exact likeness of the original photograph. Three-colour half-tones, in the form of yellow, red and blue plates, with the addition of a black plate in the case of four-colour sets, reach the machine manager from the blockmaker via the Composing Room, together with a set of "progressive proofs" to serve as colour guides.



A small jobbing press

Difficulty is encountered in matching these colour proofs. The blockmakers frequently proof colour blocks singly and are therefore able to obtain the exact colours required. When printed, however, quite a number of blocks may have to be put on the same large sheet of paper, and it is not always possible to produce the exact shades of colour in each of the individual blocks.

Another standard which has deteriorated recently is the trimming of blocks by the blockmakers. All colour blocks when printing are "registered" from the centre, and when the different blocks are not trimmed to precisely identical sizes colours appear incorrectly round the edges.

The paper is a very important part of the colour printing process and is normally good quality white art. Its whiteness and smooth surface are necessary to show the colour hues in their proper purity or brilliance. Ink is said to be "opaque" or "transparent", but, with the exception of metallic inks such as silver, copper or gold, printing inks are rarely completely opaque and are never transparent in the accepted sense of the word. All inks are, in fact, translucent and vary only in their degree of translucency, this being the reason why the whiteness of paper adds to their brilliance—off white paper diminishes the purity of the colours as printed.

Still on the subject of paper, it should be mentioned that it is hygroscopic, i.e. its fibres are affected by both air temperature and humidity. It is therefore susceptible to changes in climatic conditions. Whilst a degree of temperature control is possible no humidity control is available at the Printing House, and if the paper expands or contracts during colour printing, register is adversely affected. To obviate this to some extent the paper is unwrapped and placed near the machine to allow it to "condition" before printing is commenced.

It is possible to vary the sequence of the printing of the colours, but when producing them one at a time a proof of the black is taken to provide a "key" sheet for the position of the block on the paper. Having established this yellow, red, blue and black are printed in that order.

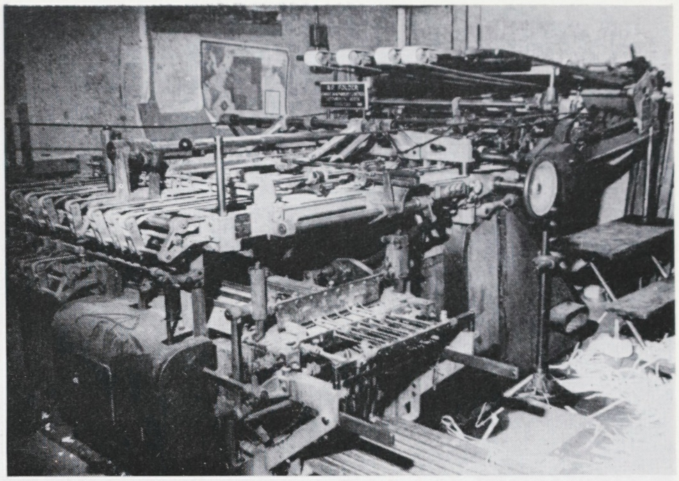
When using the two-colour machines the development of modern printing inks enables "wet on wet" printing, i.e. yellow is printed at one end of the machine followed immediately by blue at the other. When dry the sheets are then passed through a similar machine which prints the red and the black at once, thus completing the four-colour sequence.

The Warehouse

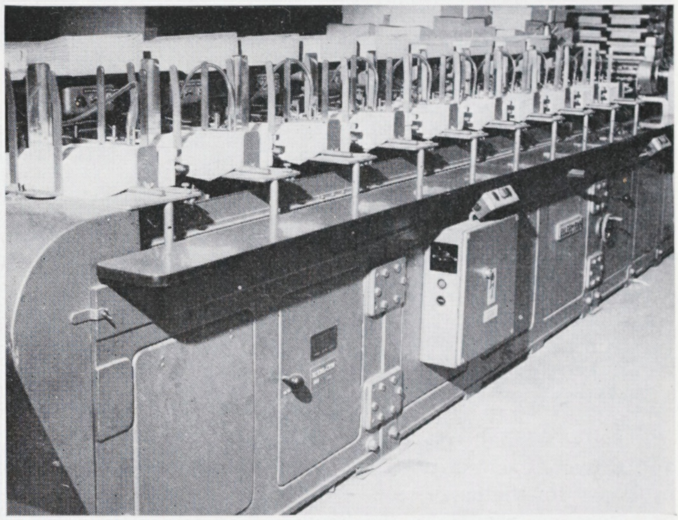
When printing is complete the sheets are taken over by the Warehouse staff. In the case of publications which are bound in hard covers, the sheets are kept in the flat and prepared for collection by the Society's binders, Messrs. G. & J. Kitcat Ltd., whose connection with Lloyd's Register dates back to 1834.

In certain other cases, when the printed sheets need to be ruled or slotted for loose leaf purposes for example, they are sent away to a Trade Ruling House, but in all remaining instances the work is "finished" at the Printing House.

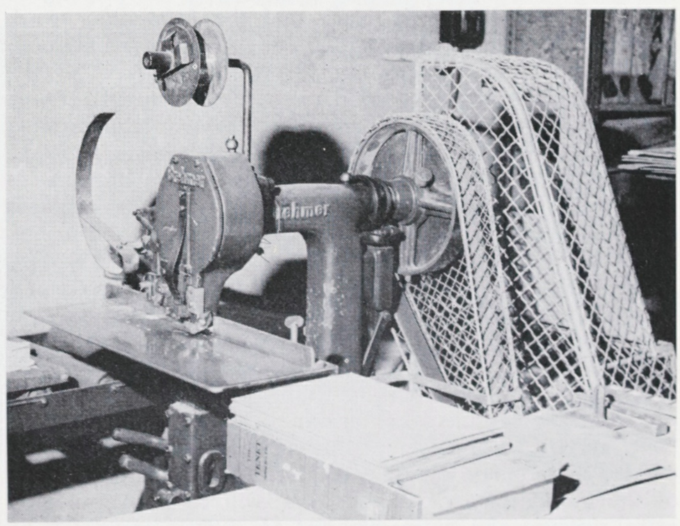
This involves the use of several folding machines, in operation for a set period each month in producing the Supplement to the Register Book, and very heavily engaged at other times of the year on the Annual Report, 100A1, Maltese Cross and brochures of many kinds, not to mention items such as the Statistical Tables, Quarterly Shipbuilding and Casualty Returns, etc.



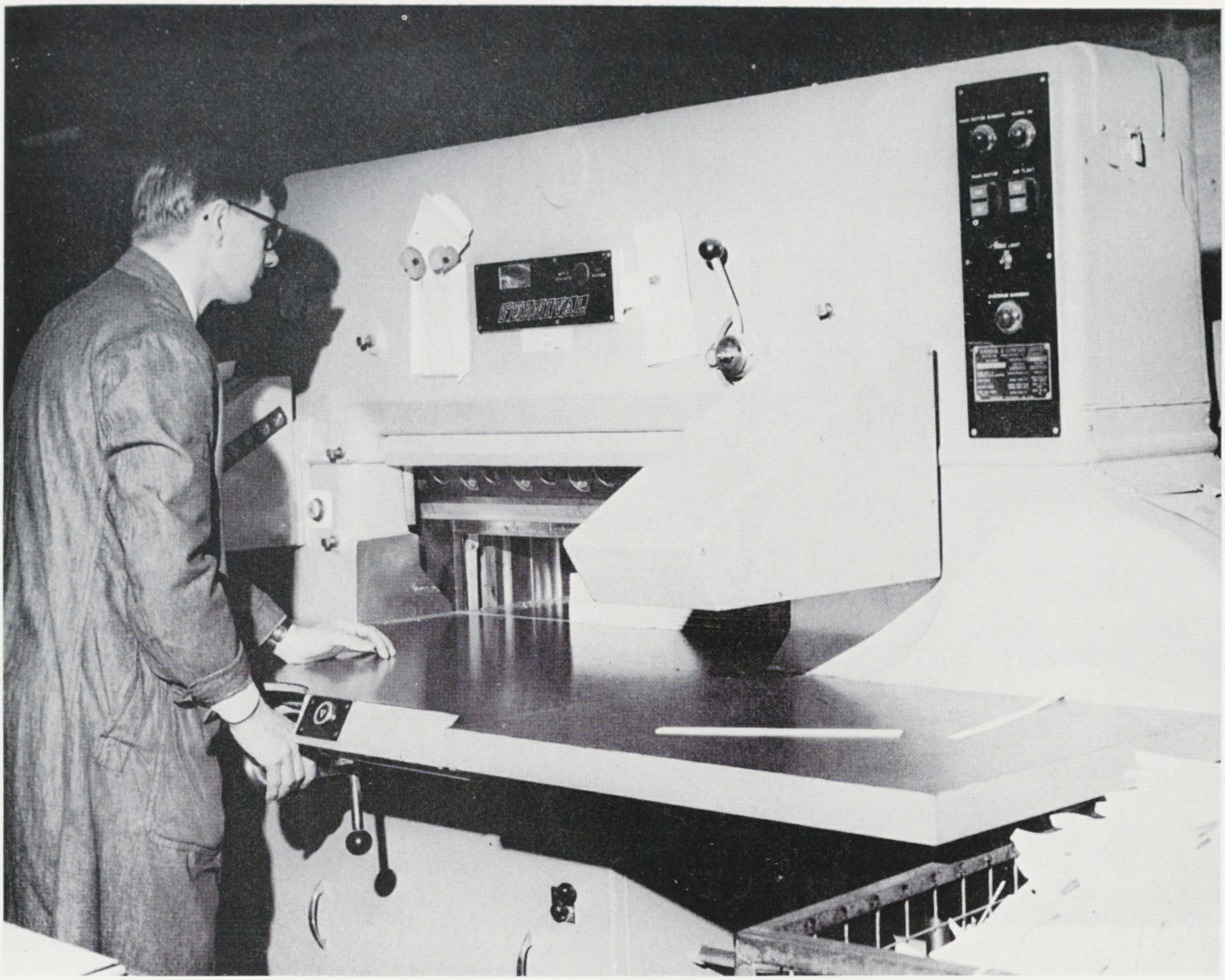
A folding machine



The collating machine



A wire stitching machine



A paper guillotine

An item such as the monthly Supplement can consist of as many as 27 to 30 different sheets, which, having been folded, have to be collated (i.e. assembled in the correct order) and a large modern collating machine is used capable of handling ten piles of sheets in one operation. Collating having been completed, wire stitching is next carried out by the ladies of the warehouse, either in the form of saddle stitching in the back of the publication (100A1, Maltese Cross, etc), or flat stitching for thicker books such as the Special Reasons List.

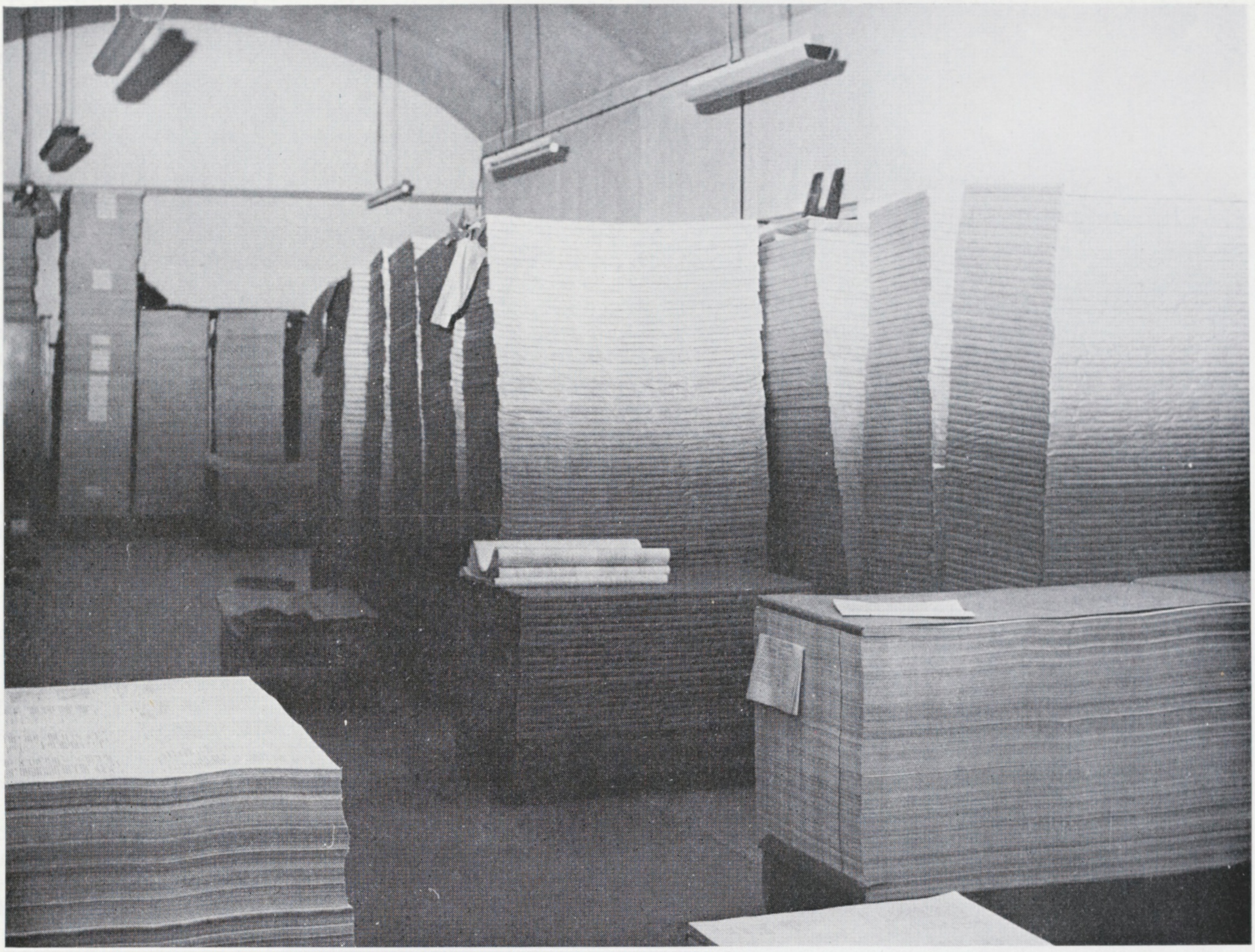
The final stage of the "finishing" is the precision cutting of the job by one of two large guillotines, and this completes most bookwork, but there is yet another process to finish the Supplement—that of drilling the holes for loose leaf filing, and the triple headed drilling machine takes care of this, with a back-up single headed machine for smaller work.

When the work has been completed it is despatched by the Warehouse staff either to Headquarters or to the various offices of the Society throughout this country and abroad. In addition all the packaging necessary to supply the Society's customers with the very many different publications produced at Crawley, is also handled.

Another considerable task is the reception of paper both direct from the Mill and from Agents, as some 350 tons is used in the course of a year's work. Of this amount 150 tons are used in the production of the Register Book and the twelve monthly Supplements. The statistically minded may perhaps like to know that the sheets of paper used in printing the 1971–72 Register Book set and the Supplements would, if laid end to end, cover a distance of 3815 miles.

Paper is such an important raw material used in the Printing House that a few notes about it may be of interest here.

It is generally accepted that papermaking was invented by the Chinese at the beginning of the second century. Little is known of their method of producing paper, but it was certainly carried out by hand, separating bark, hemp and rag fibres and soaking them in water. The pulp thus produced was placed in a bamboo frame having a cloth base and then agitated, allowing the surplus water to drain away, leaving the



A section of the paper storage area

fibres in the form of a primitive and coarse sheet of paper.

Mechanisation was not finally achieved until the invention of a papermaking machine in the latter part of the nineteenth century, and the materials used up to this period were chiefly linen and cotton rags, but these have now been largely superseded by wood-pulp and to a lesser degree by esparto grass.

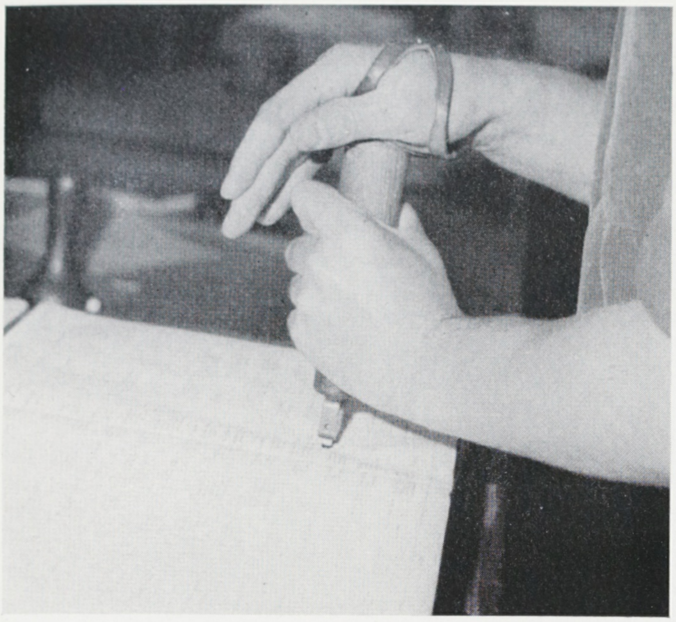
There are innumerable varieties of paper, but these can be broadly divided into the two groups of "writings" and "printings", the former differing from the latter in the extra amount of size that is added during manufacture.

Banks and bonds are both terms applied to writing papers—banks being those of a lighter weight than 15 lb. for 500 sheets of Large Post size (16″ × 21″), and bonds those of a weight above this limit. Both these types of paper are in extensive use at the Printing House.

For the high quality colour work in the Annual Report and special brochures Art paper is used, which is made in two separate operations. A thin body paper, usually containing a high proportion of esparto grass, is made, which is then coated with china clay and calendered to give a very smooth surface. By varying the coating material and the amount of calendering different surfaces can be produced, ranging from a high gloss to a matt finish.

For work such as Technical Association papers, and also reprints of technical papers, etc., an imitation art paper is required. This has china clay added at the pulp stage and after manufacture is damped and heavily calendered. This gives a fair degree of polish, rendering it suitable for illustrated publications.

The Register Book is printed on a specially produced bible type printing paper which, although very light in weight, is extremely strong. It is made from a blend of various woodpulps chosen for the length of the fibres they produce, thus giving the paper added strength. The pulp is very well beaten and a percentage of titanium is added to give the necessary opacity. The "furnish" of the paper is completed by a small amount of china clay, resin sizing and a very small percentage of dye for colour matching.



"Posting" the Register Book

The Posting Department

The remaining department to be mentioned, although not directly connected with the printing processes, is easily the oldest in its direct relationship with the Society. As has been mentioned earlier, the first Printing House was not established until 1891, whereas the "posting" operation, which is the hand correction in type of the printed pages of the Register Book, was commenced in 1775.

Before the building of the first Printing House the work of "posting" was carried out at the various Headquarters of the Society, first at Castle Court, Cornhill, and from the 1840's onwards at White Lion Court, Cornhill.

The earliest records show that there were eight Posters on the staff in 1860 and this number increased steadily until the peak year of 1921, when the staff numbered 58 and subscriptions to the Posted Book had risen to the highest recorded figure of 1012.

In the ensuing 50 years the numbers in the Posting Department have declined, although there were still 44 staff in 1954 after the move to Crawley. The introduction of a new format for the Register Book in 1955 and a consequent sharp increase in price—from 35 guineas to £80—caused a drop in the number of subscriptions from 667 to 126. The number of staff is today back to the 1860 figure of eight.

Of this number, only four men do the actual "posting", using "hand cases" of type set up by the two compositors, yet they manage to achieve an average of 3700 impressions per day. Working to a weekly routine, a certain number of books are brought down from London daily, the corrections are made and the volumes are returned to the Subscribers on the following day. It is believed that the hand correction method of up-dating the posted Register Book is unique and the service given must be considered worthwhile by the handful of firms in the City who now pay the sum of £250 annually for the privilege of having their books altered by this method.

CONCLUSION

This paper has given a brief description of the Printing House and its various functions, which it is hoped will give an insight to all in the Society concerned with the printed word. One point should be emphasized, however, to those so connected, especially to authors of papers. A considerable amount of time is lost at the typesetting stage by having to deal with authors who do not apparently know what they want to say until they see it set up in type. Frequently manuscripts are received which are set and sent out in proof form, only to be returned in such a mutilated condition that a complete re-setting operation is necessary. Such cases take double the time which should be needed in both the typesetting and reading operations.

If these extensive alterations are made at the galley-proof stage they are delaying enough, but when they occur later, at the page-proof stage, they are even more time consuming, involving as they do, the transfer of type from one page to another, with consequent dislocations which may mean altering pages through the entire publication.

Printed by Lloyd's Register of Shipping at Garrett House, Manor Royal, Crawley, Sussex, RH10 2QN, England

Lloyd's Register Technical Association

TOWAGE SURVEYS AND ASSOCIATED WORK

K. van Duffelen

Paper No. 5. Session 1972-73

Hon. Sec. C. Cummins
71, Fenchurch Street, London, EC3M 4BS

TOWAGE SURVEYS AND ASSOCIATED WORK

Synopsis

This paper deals with the recent activities of the Rotterdam office in relation to the issue of certificates certifying a vessel's fitness to be towed and/or the fitness of a ship to carry a certain unusual cargo. It covers some notes on the general principles laid down in the Instructions to Surveyors and adopted in carrying out the survey work, including such aspects as structural strength, means of preventing admission of water, freeboard, stability and stowage and securing arrangements, etc.

The survey of towing arrangements is also described.

The practical application of the foregoing is shown by describing typical cases ranging from the towage of a damaged ship of normal shape and proportions to the towage of unmanned pontoons used for transporting heavy contractors' plant, and includes the loading, stowage and securing of exceptional cargoes.

Preface

To fully cover the subject suggested by the title would entail an unwieldy amount of text, mainly theoretical. Consequently an effort had to be made to confine the material to that of practical interest. As this contribution was in the first instance written for the outdoor Surveyor who has to deal with towage surveys or associated work, a certain compromise was needed and sophisticated details of design and calculations have been avoided, but practical information is given as to how such surveys have been conducted.

Further, there is an infinite variety of ways of solving many of the problems encountered in this type of survey. Many solutions are affected by local know-how and local facilities, and are subject to controversial ideas. Perhaps this is one of the reasons that this type of survey has its attraction for the Surveyors concerned. It should always be realised that especially nowadays the variety of vessels and their cargo is such that in spite of the experience of the Master and his crew, their best efforts may fail if the vessel in question is not prepared in a suitable manner for the contemplated voyage.

Towage Surveys

For ready reference a copy of the Revised Instructions to Surveyors, Part 11, 1954 (ii), on towage surveys is attached to this paper, Appendix A. Comments and additional information given in this chapter use the same paragraph numbers as reference.

1 & 2. In view of an increasing number of requests to certify the fitness of ships to be towed, guidance notes were drafted about ten years ago with information and advice to the Surveyors conducting the surveys and since then revised notes have been issued. Many cases covering various types of vessels have been dealt with during this time and, as a result of the experience gained, the Society is able to issue certificates for Underwriters and at the same time assist owners and towing companies in the technical preparation of various types of vessels and equipment.

While beyond any doubt several ports have built up a large experience, there may be ports in this field which are not so familiar with certain types of work associated with towage, but the experience of other ports is available through Head Office. For example, consider the use of camel-pontoons. This is the transport of cargo by unmanned towed pontoons.

This method of transport has been developed in recent years and has been successfully operated especially when dredgers and their equipment (pipeline, pontoons, etc.) were to be transported in one operation.

The principle of this method is that the large pontoon is fully or partly submerged and the craft to be transported is lifted out of the water when the pontoon is refloated. A typical pontoon used for this purpose, is shown in Fig. 1. No doubt the loading operation, when carried out in an empty graving dock, where the cargo can be positioned on the deck of the submerged pontoon gives a minimum of risks. Several cases are known where the floating operation has been done in the harbour, sometimes using the tidal effect. The refloating operation when carried out at a suitable place usually presents no major problems.

Using large seaworthy pontoons, the freeboard and stability of which are always checked, seldom presents any special problems, The freeboard, stability and structural strength of the craft to be carried are no longer relevant. The main problem to solve is the securing of the craft on the deck of the pontoon. Obviously, when the craft's bottom and/or the deck of the pontoon, are not flat extra measures and precautions have to be taken.

Usually the securing of the deck cargo is done by fitting heavy struts and brackets on the deck of the pontoon and the typical support used for this purpose is shown in Fig. 3.

The actual dimensions and position of supports are dependent on the weight and construction of the ship to be loaded and the pontoon to be used.

The securing of smaller items loaded on the pontoon is also done by fitting welded struts, brackets, etc. Generally the use of wires or chains is not considered efficient on an unmanned tow, as they tend to loosen in a seaway and are difficult to tighten adequately initially. In practice the required support and securing arrangements are easily achieved by simple welded constructions.

3. The importance of the survey of the towage arrangements cannot be stressed too much. It should always be realised that failure of the towage arrangements in many cases ends in a lost tow (*see further under* 22).

4. The preparation of a fully classed ship for towage usually does not present any major problem and normally all required information is readily available.

With unclassed craft it is of the utmost importance to obtain the required information in respect of condition, strength, scantlings, freeboard and stability at an early stage in order to make up a list of recommendations and usually some initiative by the Surveyor is required in this respect. Special care should be given to ships with unusual proportions.

5. In spite of the fact that even in the case of unmanned tows, certain sounding and pumping arrangements are required for use in case of emergency. It is therefore considered to be of prime importance that the risk of water entering the hull is limited to the very minimum and hose testing to prove watertightness is essential.

Due regard should be given to the arrangements for freeing water from deck; any water breaking on deck should not be trapped, so endangering the ship in many respects. The fitting of breakwaters and additional freeing ports should be considered.

TRANSPORTATION OF FLOATING DREDGING MATERIAL ON A SEA - GOING SUBMERSIBLE PONTOON

The principal advantages are,

*Small floating material unsuitable for towage overseas can now move by this method

*High costs are eliminated in making floating material ready for sea

*Lower insurance costs

*Material instantly ready for use at destination

*All the necessary parts including the non - floating items are taken in one transport, saving extra shipment costs

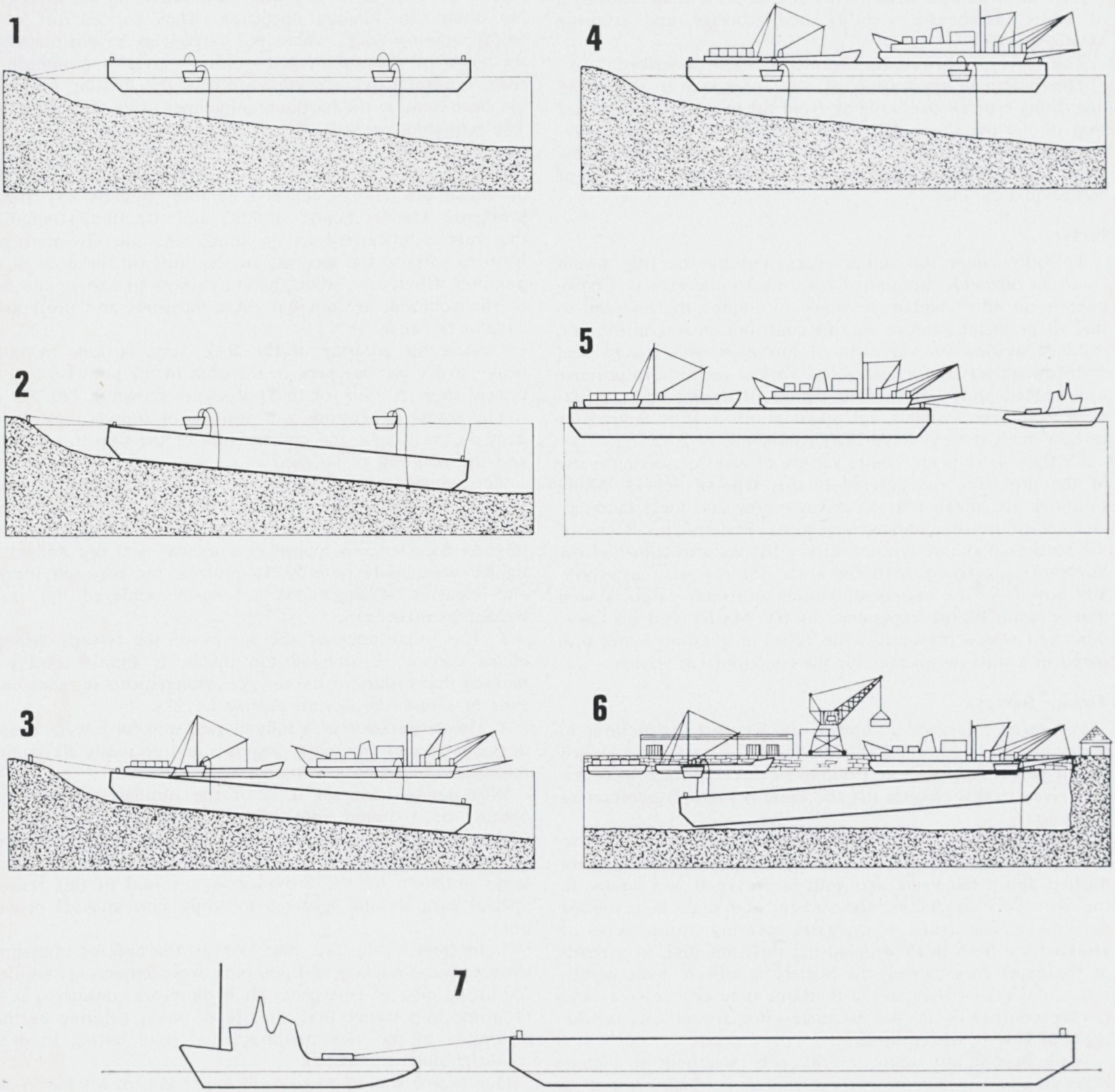


Fig. 1

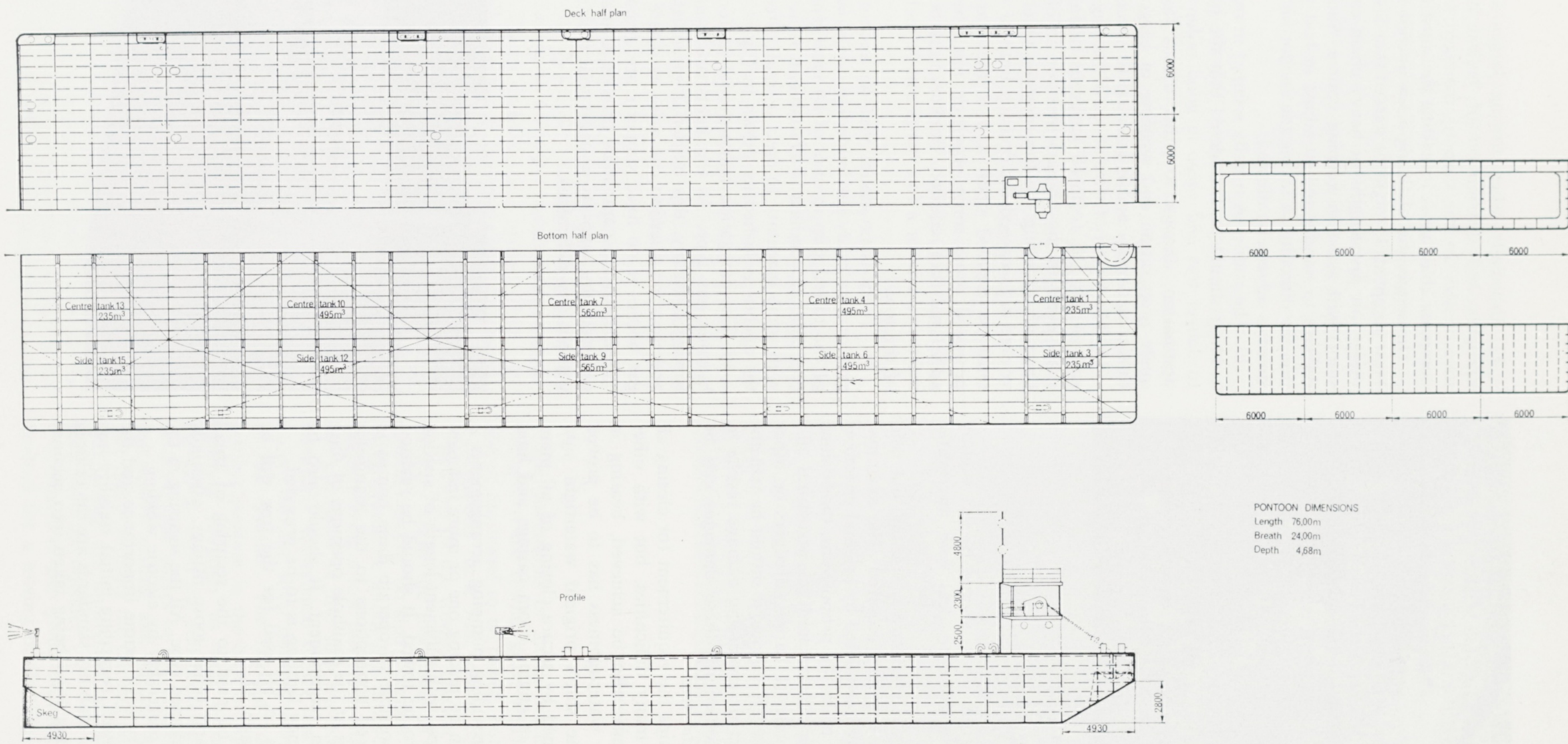

Deck half plan
6000
6000
Bottom half plan
Centre tank 13 235m³
Side tank 15 235m³
Centre tank 10 495m³
Side tank 12 495m³
Centre tank 7 565m³
Side tank 9 565m³
Centre tank 4 495m³
Side tank 6 495m³
Centre tank 1 235m³
Side tank 3 235m³
4680
6000
6000
6000
6000
4680
6000
6000
6000
6000
PONTOON DIMENSIONS
Length 76,00m
Breath 24,00m
Depth 4,68m
Profile
4800
2300
2500
Skeg
4930
2800
4930

FIG. 2

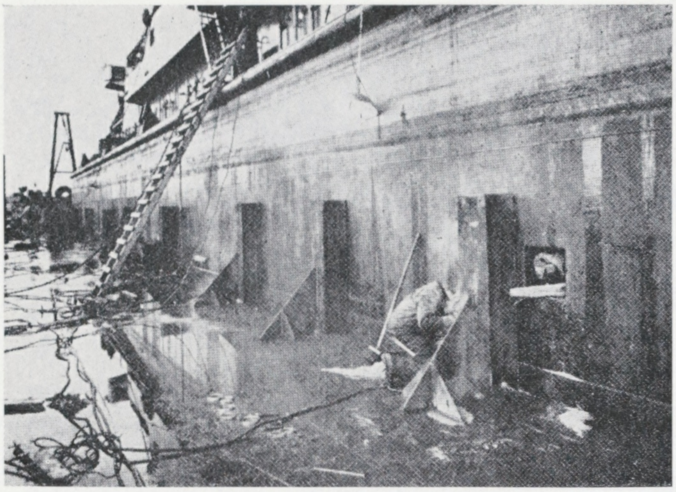


FIG. 3

Showing brackets welded to deck of pontoon.

In hopper barges the bottom doors should be left slightly open and secured in this position to deal with any water shipped during bad weather.

6. For ships not classed, an extensive opening out and survey of the hull in dock is usually required. The examination in dry dock should be complemented by internal examination. In the absence of any plans the proportions, dimensions and scantlings should be verified to check the structural efficiency of the hull. In the case of barges, dredgers or other vessels, which are built for severe service, it should be remembered that not every contact or grounding damage results in structural deficiency and sometimes these damages can be regarded as normal wear and tear.

7. In case of sea-going ships the requirement for closing all openings will not present many difficulties, but with other craft the same standard must also be achieved, bearing in mind that in all cases the watertightness has to be proved prior to going to sea. The ship's original watertight subdivision should be maintained by secure closing of all manhole and watertight doors in engine room casings and hold and 'tween deck bulkheads.

8. The requirement of providing pumping arrangements is in many cases complied with by placing one or more independently driven portable pumps, with sufficient length of suction hose, on board the vessel to be towed. It should be realised, however, that it must be possible to operate these pumps in case of emergency and fixed connections to the manifolds and/or detachable coamings at the manhole openings of flush deck barges is a minimum requirement. It should also be considered whether emergency lighting is to be provided.

9. Bollards and fairleads to be used for the tow will be further described in paragraph 22.

10. Special care should be paid to the securing of small items as derricks, booms and other loose fittings, especially when the tow is of the unmanned type. All the securing in the latter case should be done preferably by electric welding.

11. The matter of stability is of prime importance and the Surveyor should satisfy himself regarding initial stability and the range of stability. IMCO stability standards are the criteria used with the effect of strong wind being taken into account (*see* Appendices).

12. Especially when towing larger ships the matters of draughts and distribution of ballast have to be carefully investigated. In the case of damaged ships, calculations by computer may assist in finding the most favourable condition.

The suggestion of fitting a sea anchor is not known to have been accepted. It might be agreed that a sea anchor of suitable design (or just lengths of heavy chain cable connected to the stern) will assist in keeping course. Such an anchor is very difficult to handle and to adjust in bad weather, not to mention the difficulty of taking the anchor on board, whilst towage speed is adversely affected.

13. The rudder is usually secured in midship's position.

14. It should be considered that the purpose of any tow is to deliver tow *and cargo* in good order and condition at the destination; damage to either means failure. Therefore adequate preparation and securing of cargo is mandatory prior to tow departure and is essential to success.

15. The matter of time at sea of the tug has to be considered and usually the required generous margin is maintained. At some point in the preparations for an off-shore tow the problem of refuelling the tug must be taken into account if the voyage is to exceed the cruising limit of the tug. Ports of call must be decided upon and if these are lacking along the proposed route some provision must be made to carry the additional fuel required. Bunkers may be carried in tanks on the towed unit or a fuel barge can be included in the make-up of the tow.

16. There is no doubt that an anchor connected to cable and/or wire ready for immediate use, contributes to the safety of the towed ship in case of an emergency. When no hawsepipe and/or windlass is available, it is in many cases possible, with some ingenuity to erect a small tilted platform on which the anchor is lashed as shown in Fig. 4.

17. The navigation lights should preferably be of the long-burning gas type. As the lights are usually supplied by the towing company, this matter is often left to the last minute and then the question can arise as where to fit the lights and gas bottles if no fixed supports are available.

Some towing companies provide a sketch showing how to construct the supports in order that their equipment will fit in without any difficulties.

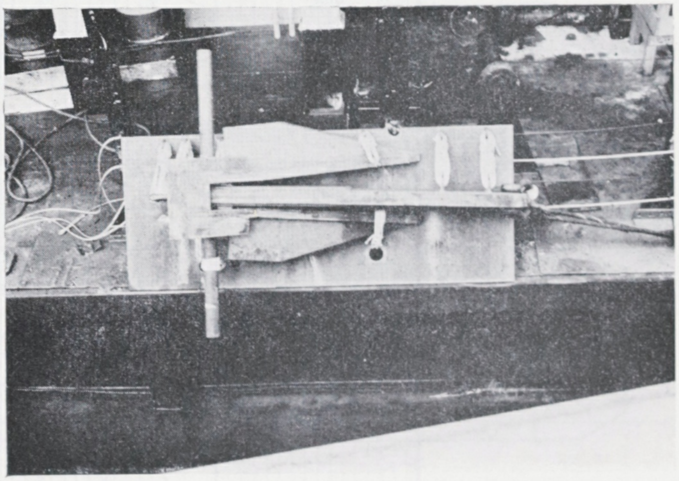


FIG. 4

The international regulations also require a towing shape on the tug and tow and three white lights on the mast of the tug when the length of the towing line exceeds 600 m.

18. The towing arrangements; this term stands for the complete outfit of wires and connections that joins a tug to its tow. The arrangements include the main towing wire, fore runner, stretch wire and bridle, as well as the smaller components including shackles, fishplates, towing bitts and fairleads securing wires at pendant lines. The towage arrangements should be sufficiently strong to withstand the dynamic loads to which they would be submitted in adverse weather conditions. Special care should also be taken to ensure that, in the event of a line parting, there are still possibilities of making new connections.

19. The question of the horsepower of the tug has always been the subject of many discussions and comments in deep-sea towing circles. Most towing companies quote the I.H.P. of their tugs or, even less satisfactory, give a calculated figure based on comparison with the I.H.P./bollard-pull ratio of less efficient tugs. Furthermore, the Surveyor who expects to find the correct answer from the Register Book and SRL Appendix (in the case of L.R. classed tugs) will be disappointed.

Today, more and more tug owners have the static bollard-pull experiment verified by an impartial body (for instance Lloyd's Register of Shipping) when a certificate to this effect can be produced.

In this case it seems more logical to accept this measurement as the criterion in considering the tug's power.

However controversial the question may be, it should be understood that when submitting recommendations for the towage of a floating object, a minimum horsepower rate should be mentioned.

The formulæ given in the Instructions should only be required as a first approach, and some comparison with successful towage of similar type has to be made. Considering, for instance, that a loaded Liberty ship was to be towed across the North Atlantic it would require a suitable tug developing not less than 1250 b.h.p.

It cannot be stressed enough that the matter of horsepower and bollard-pull is not the only governing factor in assessing the tug's ability for the proposed tow. Apart from size and type of the vessel to be towed, the tug's displacement, draught, manœuvrability and bunker capacity are factors which also have to be taken into account. It should be noted, however, that a larger tug with the higher horsepower available (and also larger bunker capacity) will give greater flexibility on long distance towages and hence more safety.

The introduction of thrusters to improve towing speed and manœuvring of large pontoons and rigs is sometimes contemplated. It is claimed that, should the towline fail, the thruster could be used to keep the vessel on a course such that the forces induced by the sea are kept to a minimum.

20. Towage of a ship by the stern will usually not occur unless the ship to be towed is in a damaged condition.

Towage of dredgers, floating cranes, etc., present different problems. Under normal working conditions that end where the dredging ladder or crane is situated is called "forward", but the towing is done from the other end. Apart from navigation lights, special care should be given to the proper positioning of towing bitts and fairleads as well as the position of the skegs, if any, in such ships.

21. When considering the minimum required size of the towline, the tug's horsepower and displacement, as well as the size and tonnage of the tow have to be taken into account. Towing speed, sea and weather conditions also have their influence. A factor of safety of four to the maximum bollard-pull of the tug is a good practice, but should not be regarded as the absolute minimum.

The actual condition of the towline and the type of thimble used at the outer end may be more important than a theoretically calculated factor of safety.

22. Chain cable bridles are still considered very efficient and safe for deep-sea voyages combining weight and strength to withstand the stresses to which they are submitted under severe weather conditions, but due to their heavy handling these chains are not always so popular with the tug's crew. To reduce the difficulties experienced in connecting up heavy gear padeyes of robust construction could be used as shown in Fig. 5.

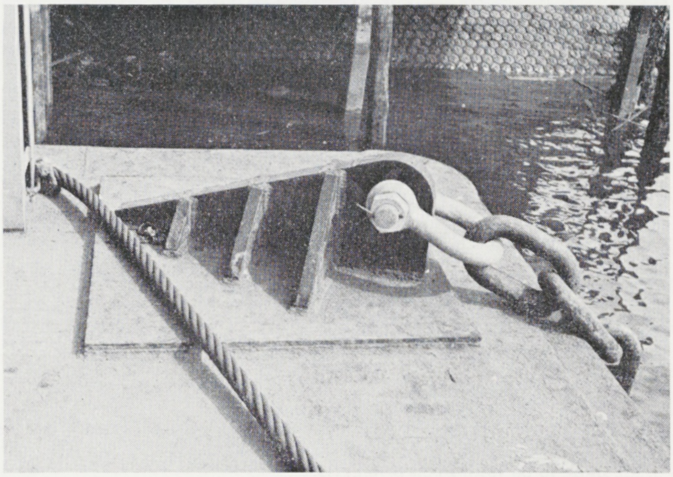


FIG. 5

The dimensions of Smith brackets vary with the breaking strength of the towing gear, which of course depends on the size of the vessel to be towed, but, for reference, a sketch of a connection for a 3-in. towing chain is given in Fig. 6.

In front of the towing bracket there should be a fairlead, through which the tow chain is led outboard to protect it against bending on sharp corners. The radius of the fairlead curve should be about five times the thickness of the towing chain. During a tow this chain may have an angle relative to the centreline of the ship exceeding 90°, either to port or starboard. Experience shows that big ships, especially with rudder damage, sheer through unbelievable angles when towed in bad weather. The fairlead could be situated in a convenient position in the bow bulwarks and might be used for mooring purposes as well. However, it must be strong enough to resist the full breaking load of the towage chain, even at right angles to the centreline. It is therefore evident that heavy plating and special strengthening are necessary. The plates forming the fairlead could be of cylindrical shape, thus giving the impression of the opening being square as seen from the outside.

A sketch is also given showing the dimensions of a light fairlead for a towing bridle (Fig. 7).

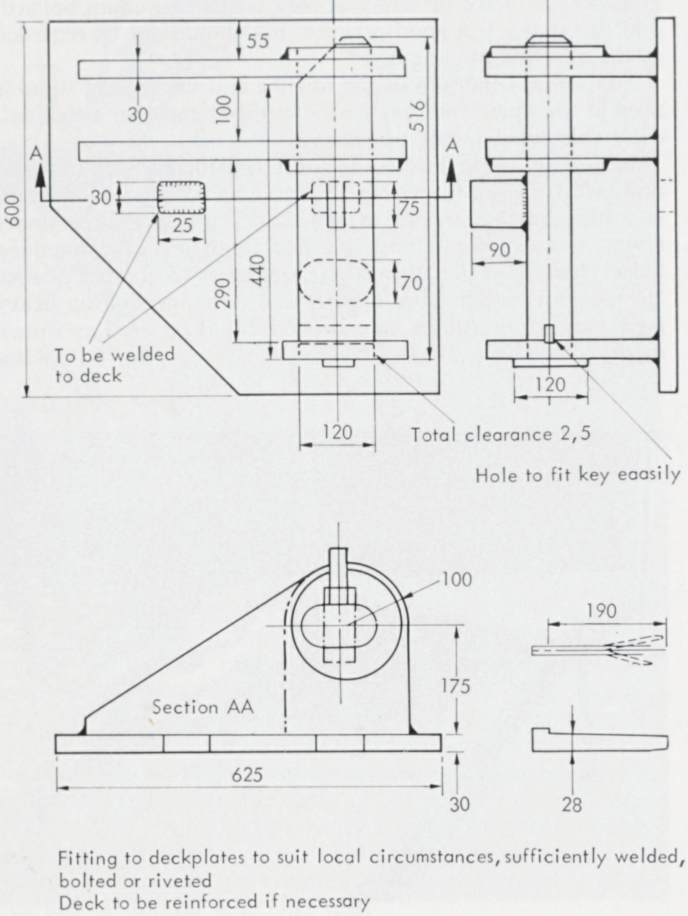


FIG. 6

Connection for 3 in towing chain.

Finally a sketch (Fig. 8) is given showing the principle of a fairlead in the bow of a large ship as suggested by Messrs. L. Smit, of Rotterdam.

In the case of heavy gear it should be remembered that without some lifting height it is not possible to recover the bridle aboard the tow by means of a retrieving line. In the case of pontoons, 8-ft. high beams provided with large eyes, have been fitted for this purpose at the forward ends of the decks or similar constructions.

When considering bridle arrangements it should be kept in mind that ease of handling and rigging should not be the first consideration. The importance of a sufficiently strong bridle cannot be stressed too much and every sea-going tug should have on board bridles of correct size and length for normal purposes. As a tug usually arrives when the preparations for towage of the ship are nearly completed, the matter of the bridle should be discussed and arranged in advance to avoid last-minute changes and arrangements.

In practically all cases dealt with a nylon spring was used between the towed vessel and the tug. The handling problems encountered with the larger sizes is reduced by using double lines (up to 2×15″ diameter).

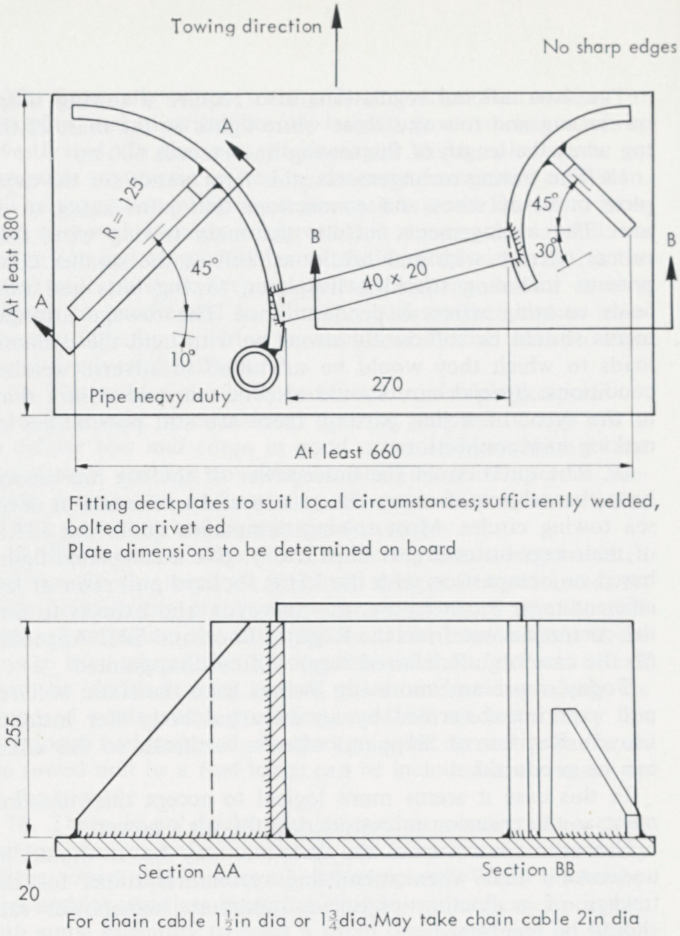


FIG. 7

Light fairlead for towing bridle.

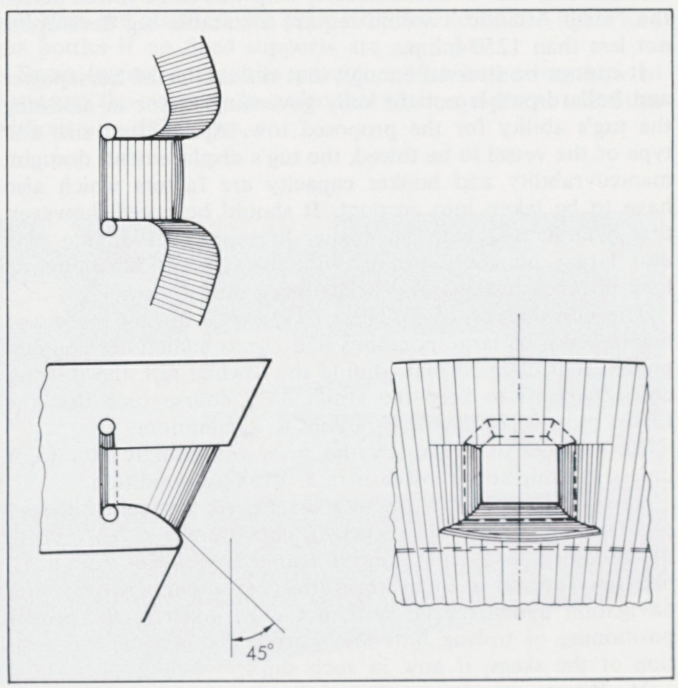


FIG. 8

Principle of fairlead in bows of large ships.

The method of obtaining the same spring effect by fitting an intermediate length of chain cable in the towline is effective but very time consuming. In the case of large barges care has to be taken that the leg length of the bridle is still sufficient. Further, in combination with nylon stretch wires, the bridle of a barge may consist only partly of chain. Each wire leg of the bridle should be at least equal to the strength of the main towing wire although normally the pull on each leg will be considerably less.

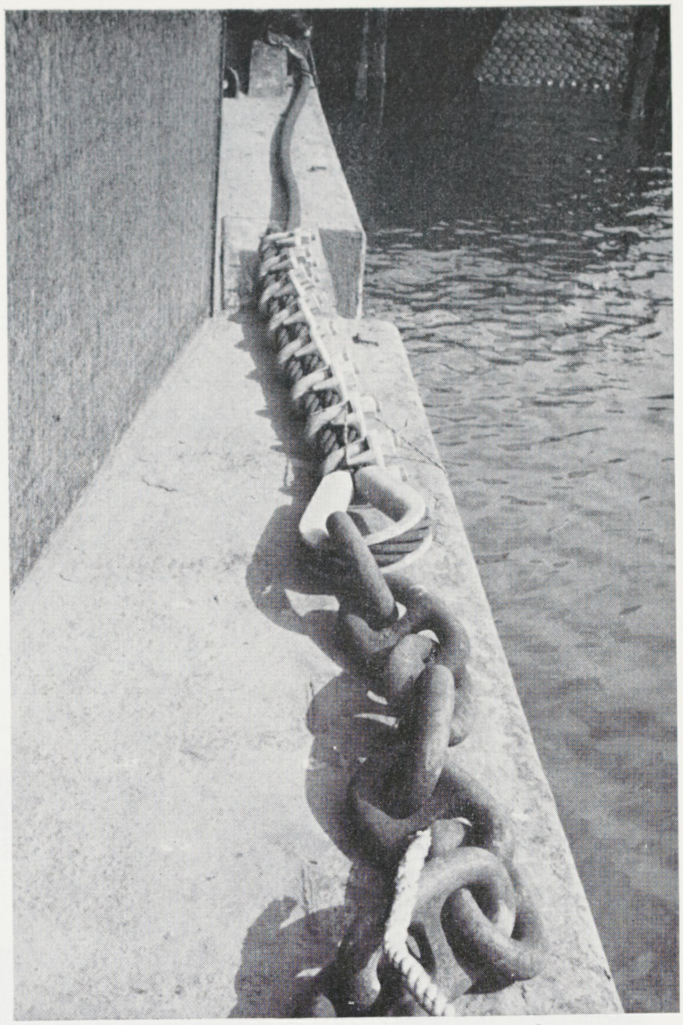
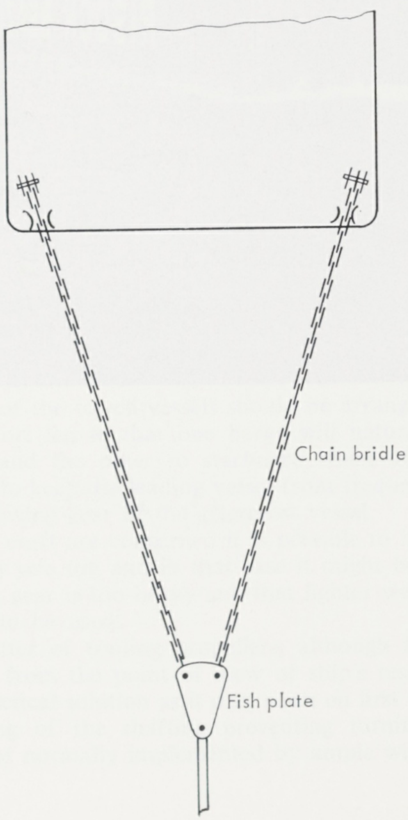


FIG. 9



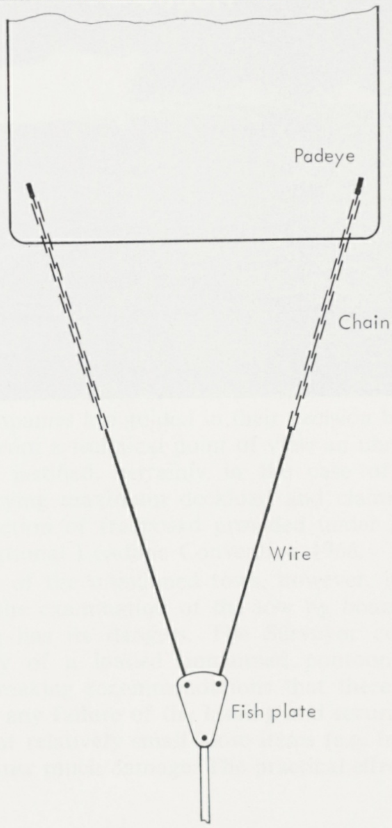


FIG. 10

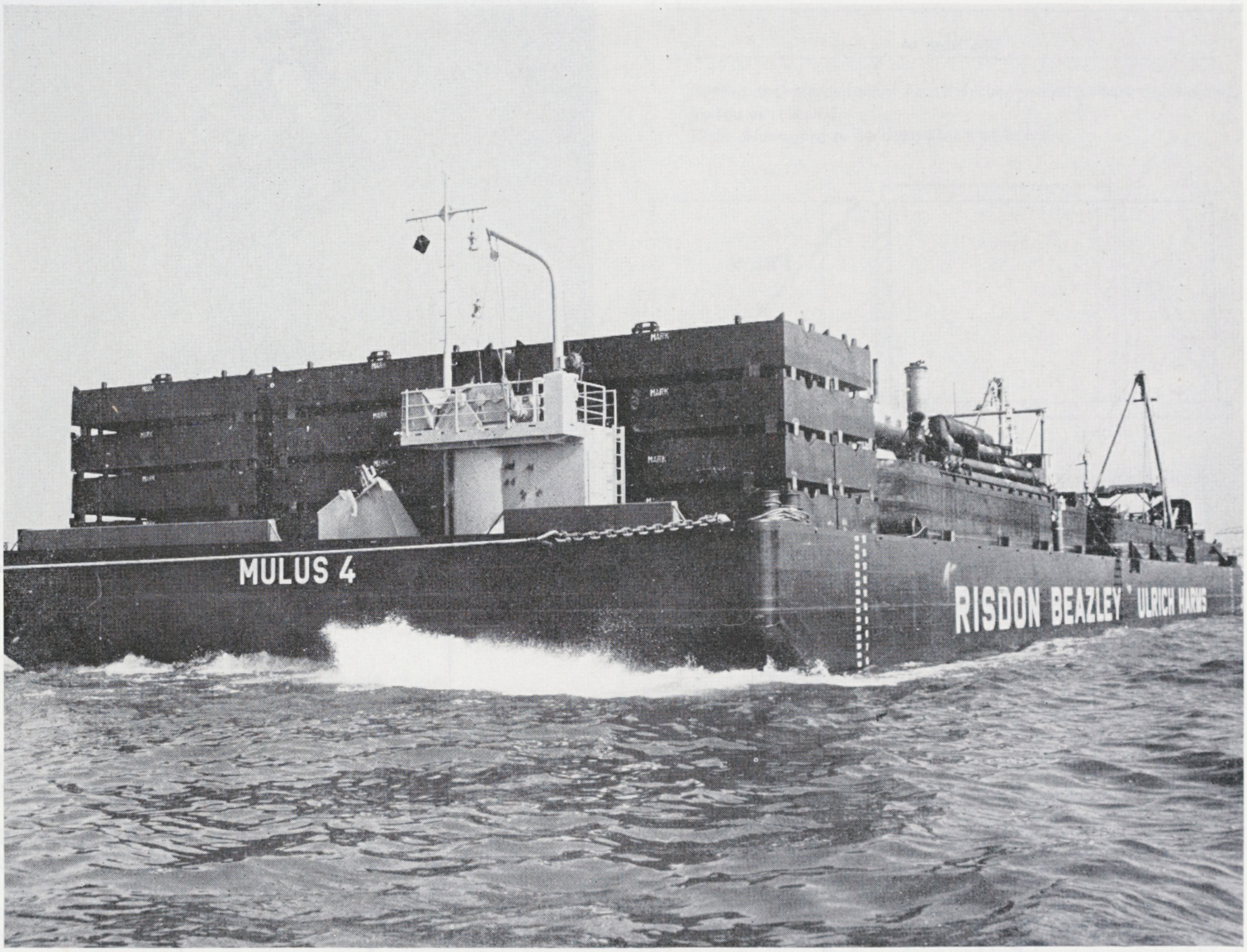


Fig. 11

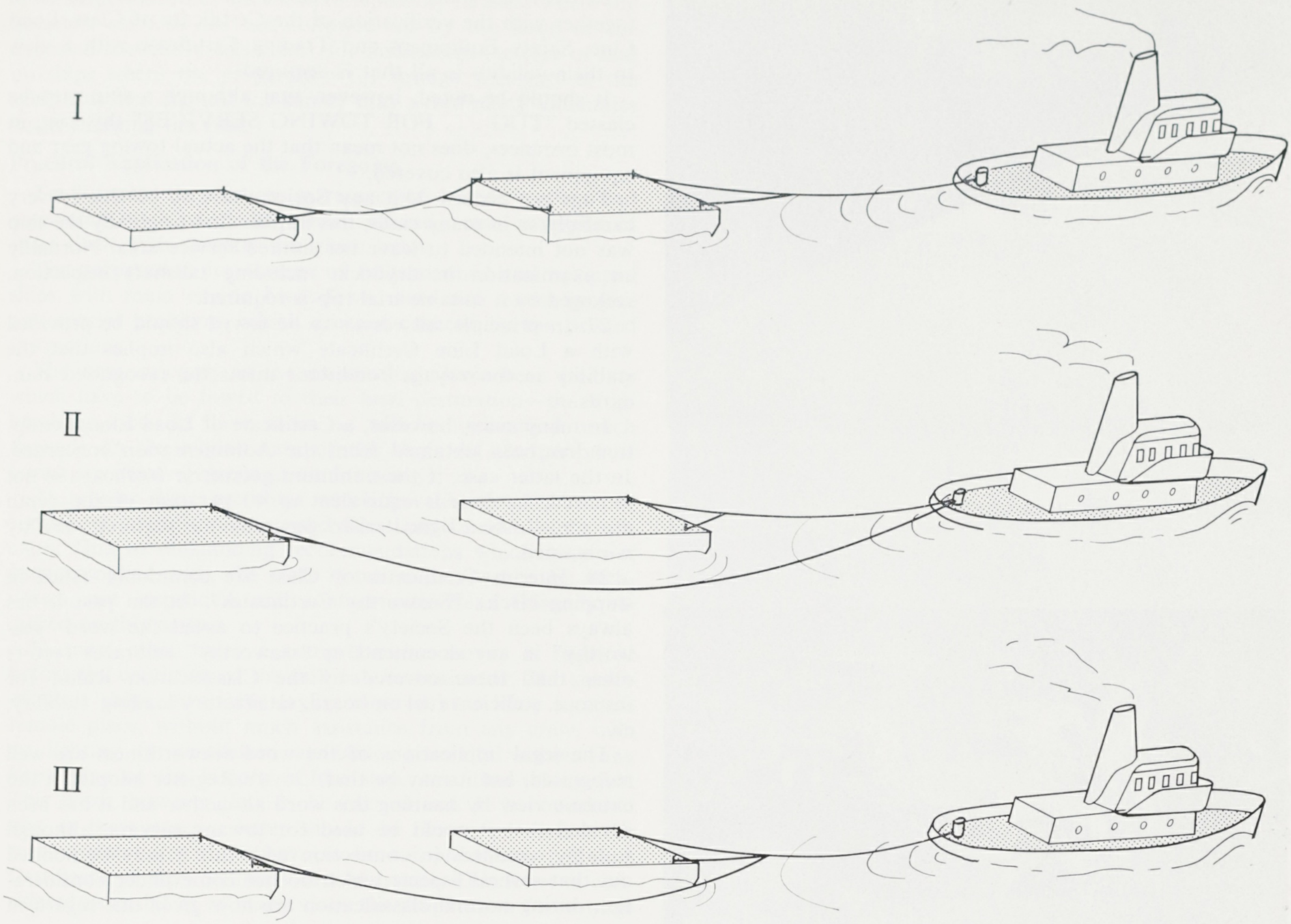


Fig. 12

Tandem Tows

The different methods of tandem tows are illustrated in Fig. 12.

When considering tandem tows Method II should be recommended, and only when the second ship is much smaller than the first one should Method III be considered. Method I is undesirable.

The bridles of the towed vessels should be arranged with a long and a short leg so that one barge will naturally sheer over to port and the other to starboard when under way. This will help to keep the leading vessel from frequently passing over the towing gear of the aftermost vessel.

When small craft are concerned it is possible to have three ships towed by one tug and in that case it might be that the normal towing gear is too heavy and that lighter weight components have to be used.

23. The matter of trailing propellers, although it may be recommended from the point of view of ship's resistance, is not such a practical solution as it may seem on first sight. The proper securing of the shafting preventing turning of the propeller is not normally implemented by ample welded construction between a shaft coupling and the ship's structure. Steel wires from the propeller blades to the stern have also been used for this purpose.

24. Whilst a tow-riding crew is still considered a contributing factor to the success of any long ocean tow, it is realised that at present more and more tows are of the "unmanned" type.

Towing companies are guided in their decision by economic reasons, but from a technical point of view an unmanned tow may also be justified, certainly in the case of unmanned pontoons carrying maximum deckload and claiming that 25 per cent reduction of freeboard provided under Rule 27(10) of the International Loadline Convention 1966.

In the case of the unmanned tows, however, it should be realised that the examination of the tow by boarding parties from the tug has its dangers. The Surveyor conducting a towage survey of a loaded unmanned pontoon should be aware when making recommendations that there will be no one to report any failure of the lashing and securing arrangements and that relatively small loose items (e.g. in the engine room) may cause much damage. The practical effect of having

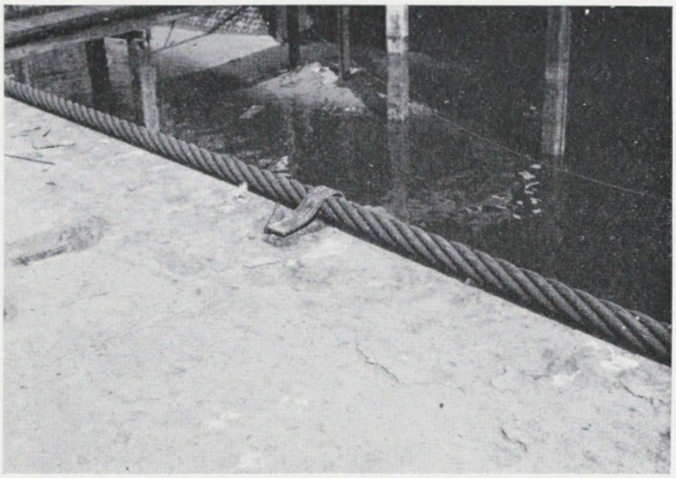


FIG. 13

Securing of spare hawser.

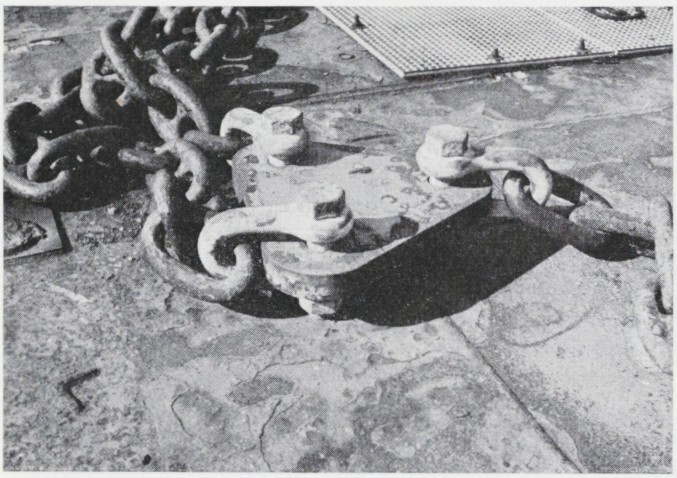


FIG. 14

Fishplate.

workable pumping arrangements and windlass are disputable as it is not likely that in case of emergency the runners can board the pontoon.

There is also the matter of the towing speed. Especially when a rather powerful tug is towing one or more unmanned vessels on a long journey, damage due to heavy weather may be expected. In this case the Surveyor should consider recommending certain reinforcements to the hull prior to departure rather than accept damage at the destination. This latter point refers primarily to craft constructed for restricted service areas which have to be towed over open sea to reach the service area.

25. The preparation of certain vessels require considerable work before actual towage can start and close co-operation with all parties concerned is essential to obtain maximum benefit from the service offered.

26. Most sea-going tugs are classed and a general inspection, together with the verification of the Certificate of Class, Load Line, Safety Equipment and Trading Certificate with a view to their validity is all that is required.

It should be noted, however, that although a ship may be classed "TUG . . . FOR TOWING SERVICES" this fact, in most instances, does not mean that the actual towing gear and equipment is also covered.

Tugs not classed with any Society have to be treated very carefully as in many cases, this implies that originally the ship was not intended to leave her limited service area. Normally an examination in drydock, including tailshaft inspection, followed by a suitable trial trip is required.

27. In principle, all vessels to be towed should be provided with a Load Line Certificate which also implies that the stability in the voyage conditions meets the recognised standards.

In many cases, however, a Certificate of Load Line Exemption has been obtained from the Administration concerned. In the latter case, if the minimum geometric freeboard is not required, freeboards equivalent to 40 per cent of the depth are sometimes assigned when generally the required stability is obtained.

28. Interim Certificates of Class are commonly called in shipping circles "Seaworthy Certificates". In the past it has always been the Society's practice to avoid the word "seaworthy" in any documents as "seaworthy" embraces factors other than those covered by the Classification Rules; for instance, sufficient fuel on board, satisfactory loading, stability, etc.

The legal implications of the word seaworthiness are well recognised, but it may be that Lloyd's Register adopted a too extreme view by banning this word altogether and it has been decided that it could be used for towage surveys, although suitably qualified. In connection with this it may be pointed out that several aspects which do not come under consideration during normal classification are now given due regard in towage surveys.

29. The Surveyors normally do not express their opinion about routeing or the weather, except when they want to express a preference for a tow to leave the port under favourable weather conditions and especially when leaving a port where traffic is considered heavy.

Sometimes it is felt that a restriction on the date may also be necessary to clear, say, hurricane seasons. In this connection reference is made to Map I of *Lloyd's Maritime Atlas* showing the world bad weather areas and periods.

The matter of excluding certain items from the survey is a very delicate question. First of all it should be clearly understood that Underwriters and their brokers who ask for a Seaworthy Certificate want a certificate from which it must appear that, taking into consideration all foreseeable circumstances, there is a normal chance that the tow will arrive safely. Care should be taken to avoid giving information about the object to be towed and the tug to be employed in such a way that, what at first sight seems to be very valuable information, later on, when all facts have become known, turns out to be much less important.

Several tug owners have adopted the good practice of instructing the tug Master not to leave with the tow until a signed copy of the Seaworthy Certificate is handed to him. It must be embarrassing for him, in these circumstances, to find that certain items have been excluded and that apparently he has to decide whether to take the risk or not.

30. Experience has shown that, especially in cases where the Society's services are not followed up by the issue of the expected seaworthy certificate (for instance in the case of laid up ships where the preparation for towage was part of the sale) a written request for survey may avoid many difficulties when charging the fees.

Practical Application of the Foregoing

To illustrate the services in respect of towage surveys and associated work which have been offered, some examples of cases dealt with recently are given below.

The preparation for towage of fully manned and equipped ships with main engine breakdown, does not normally give any special problems, which are not covered by the printed instructions.

The next category is the ships which have been laid up which have to be towed to their final destination—the ship-breaking yard. In these cases, as will be understood, much depends on the actual state of the ship and the period of laying up prior to preparation for sea.

At present there are ships which have been taken out of service whilst still holding valid Class and Load Line Certificates. Due to outstanding recommendations which have not been complied with, the class notation has had to be withdrawn, not suspended, and contact with Head Office is required on this matter.

In most other cases a comprehensive survey is required before the condition of the hull can be evaluated. The survey of these ships, invariably laying moored at a buoy in some remote place, without much assistance from any crew, with no lighting or ventilation available, generally without any knowledge of the history of the ship, is a time-taking job. This work, however, has to be carried out. It is considered that in these cases a letter should be drawn up stating the recommendations which have to be complied with before a Certificate of Seaworthiness can be issued. This letter is considered essential as in many cases the preparation for towage is part of the deal and difficulties with the parties concerned may arise when there is any doubt about the number and nature of the recommendations made.

The matter of placing a boarding crew on board should also be considered at this early stage with a view to providing safety equipment.

At present these ships are often towed as unmanned vessels. Fig. 15 shows a ship leaving port after being sold for scrap.

FIG. 15

Towage in Damaged Condition

One typical form of survey is that in connection with damaged ships which are, at first sight, so severely damaged that it would appear that repairs would have to be effected at the place of salvage or at least very expensive and time-consuming temporary repairs would be required to obtain a further Certificate of Class.

FIG. 16

Vessel after collision in the River Scheldt.

This is not always in the interest of owners and/or insurance companies. It is in these cases that a towage survey should be considered enabling permanent repairs to be carried out at a port more convenient to the parties concerned.

Case 1

A typical report of one of these surveys is given herewith dealing with the case of a 5000 tons dwt. cargo ship. It had been in collision with a large bulk carrier and sustained extensive damage in the River Scheldt during dense fog while on a loaded voyage to Antwerp.

The bulbous bow of the bulk carrier pierced the port side shell plating in way of No. 2 hold coming in contact with the forward bulkhead of the engine room, consequently flooding the hold and engine room. The water level reached the top of the main engines and finally flooded the tunnel.

Through a broken bilge line No. 1 hold was also flooded, the pipe being broken in way of the damaged shell and bilge of No. 2 hold. The ship was put aground where the port suction of No. 1 hold was blanked off and the hold pumped out after part of the cargo had been discharged. The port anchor and part of the chain cable had to be left at the site of the grounding as no power was available for the windlass. (One link had to be cut.)

By further discharging and the use of a floating sheerleg, the ship was refloated and put in the drydock at Sloehaven.

It was found on examination that the greater part of the shell plating on the port side in way of No. 2 hold had been pierced, the opening extending from the margin plate to the sheerstrake. The sheerstrake was badly buckled and fractured at the shell door and the deck stringer plate set down. The forward bulkhead of the engine room was set in, pierced and fractured in several places. The lower 'tween deck in No. 2 hold aft had been torn off. The midship deckhouse and the forecastle were also damaged.

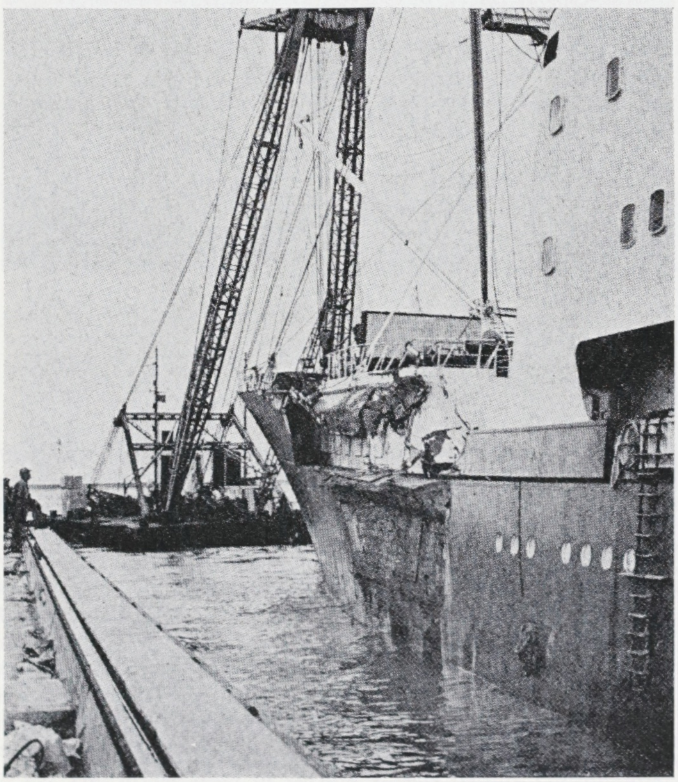


Fig. 17

View of damage at deck level.

On examination in drydock no further bottom damage could be ascertained, apart from a few indents in side shell caused by the lighters when discharging at sea. The owners requested recommendations for temporary repairs to be carried out to enable the ship to be towed coastwise to Germany with No. 2 hold flooded and left open to the sea.

After considering the longitudinal stresses in damaged condition the following temporary repairs were recommended and carried out, the ship being still part loaded:—

(a) False sheerstrake plate was fitted about 2600 mm wide × 19 mm thick extending down to the second deck level over the full length of the damage and overlapping the intact structure.
This plating was supported at every second frame as far as practicable.

(b) A heavy section was fitted over shelter deck at portside covering the damaged area and overlapping the intact structure.

(c) The lower part of the engine room bulkhead on portside—about 5,3 m × 2,7 m was renewed.
At the level of the lower 'tween deck a stringer plate was fitted and the remainder of the damaged plate reinforced by fitting webs, restoring the full strength and watertightness.

(d) Upper and lower extremities of opening in shell were trimmed.

The port anchor and cables were refitted and the damaged length disconnected and stored on the deck. A hand gear for the windlass was rigged.

Temporary pumping arrangements were fitted as follows: four diesel-driven pumps (60 tons per hour capacity), one in engine room, connected to bilge manifold, one to port engine room bilge, one to bilges No. 1 hold and one standby. Oil navigation lights were fitted.

The rudder was secured to the stern by welded struts and brackets.

The ship was ballasted so that a small hogging condition was obtained.

The calculations for stability made by the owners showed an initial stability of 0,33 m corrected for free surfaces and a positive arm up to 75°.

As the ballast condition resulted in a trim by the stem, a tow by the stern was recommended. This also reduced pressure on the engine room bulkhead. The towage arrangements were further made as indicated in the Instructions to Surveyors.

On completion a Seaworthy Certificate was issued stating that the ship, with her towing arrangements, was in a fit condition to proceed to Hamburg (coastwise). This tow was only to depart under good weather conditions and the certificate further stated that the class of the ship was temporarily suspended for the voyage and that the stability was the responsibility of the owners. The voyage was successfully completed.

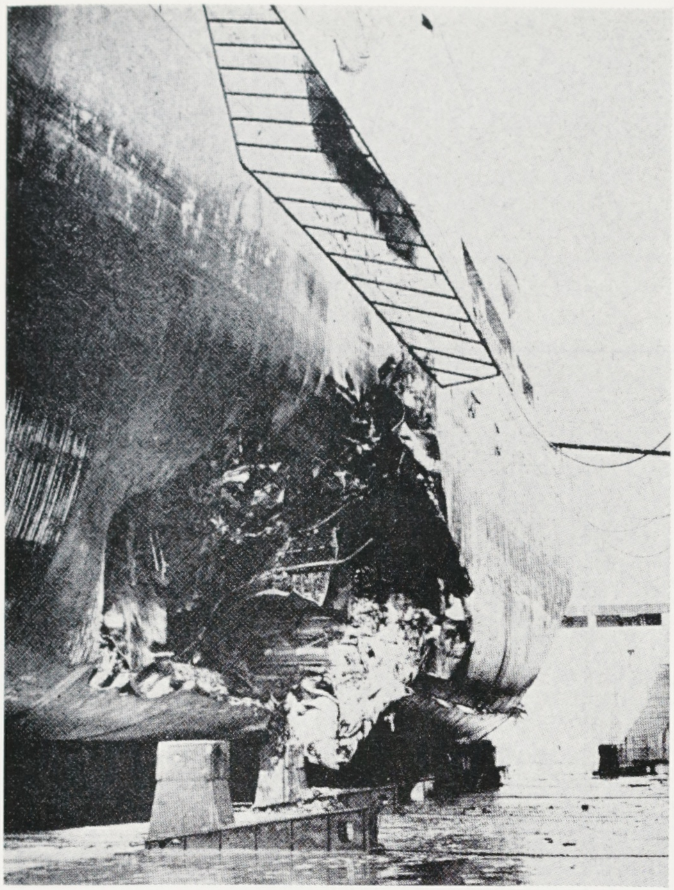


FIG. 18

Showing position of false sheerstrake.

Case 2

A similar case was that of the 80 000 tons dwt. tanker, which was lying at Rotterdam, after a spectacular salvage operation and which was recorded in the supplement of the Register Book STRANDED—DAMAGED BY FIRE AFTER COLLISION 10/70, NOW REFLOATED 11/70, IN PORT DAMAGED 11/70.

The extent of the damages which can be partly seen on the illustrations, was reported after superficial inspection as follows: —

(a) *Contact damage*: starboard side shell plating, sheerstrake, first strake below and second below from middle of poop to No. 5 tank starboard side. Further indents in way of the poop in 3rd, 4th and 5th strake below sheer.
Internal structure: bulkhead between No. 5 tank starboard side and cofferdam (pump room) cracked. Bulkhead between bunker and engine room cracked in places.

Longitudinals, etc., damaged.

Shellplating: No. 2 tank, sheerstrake and first below set in.

(b) *Grounding Damage*
After end of vessel set up, keel free from keel blocks over approximately 33 m from centreline of rudderstock to forward, maximum about 8 in.
Sternframe bent upwards, rudder blocked between sole piece and stern, rudder plating set-in in places.

(c) *Explosion Damage*
Shell plating in way of No. 5 tank of starboard side and cofferdam blown to outside and sheerstrake, 1st, 2nd, 3rd and 4th below, greater part missing; strake 5 fractured and together with strakes 6 and 7 more or less blown out. Internal structure in way of tank No. 5 and cofferdam damaged if not missing.
Deck plating cracked, buckled, part bent down starboard side, damage extends to port side about centre of derrick post, internal structure distorted.
Engine room burnt out, poop, deckhouse burnt out and seriously damaged.

The owners requested the issue of a Seaworthy Certificate for a voyage in tow from Rotterdam to Hongkong, of course with a minimum of repairs to be effected. After further inspection of the damaged areas the longitudinal strength aspect was investigated by using L.R. longitudinal strength computer program 76 for several feasible ballast conditions to arrive at an optimum and, as a result, recommendations were made for temporary repairs to be effected, leaving No. 5 wing tank open to the sea, but further restoring the watertightness of the damaged division bulkheads and incorporating stiffening and reinforcement of the damaged deck and shell area.

Amended freeboards, corresponding to the actual draught were assigned and a Load Line Certificate to this effect was issued, covering the voyage in tow.

On the Seaworthy Certificate issued the ballast condition and draughts were specified.

The tow was commenced by the tug Rode Zee and successfully completed by the tug Zwarte Zee.

Towage of Special Service Ships

Another type of towage survey is that in respect of special craft, usually designed to operate in sheltered waters, which have to be transported from the builders' yard to a service area or from one service area to another. Some of these voyages are deep-sea towages covering long distances, others cover shorter distances but over areas where adverse weather conditions can be expected.

In these cases, apart from the structural strength point of view, the aspects of loadline and stability are usually the most important factors to be investigated when considering if a tow on the vessel's own keel is possible.

The Society's Rules and Regulations for the Construction and Classification of Steel Ships state that a character of classification and class notation can be assigned by the Committee to sea-going ships intended to operate within specific limits, and also to ships intended to operate only within sheltered waters such as harbours, rivers or estuaries. For this category of ships it might be advisable to investigate the possible conditions for obtaining a Seaworthy and Load Line Certificate for the delivery voyage, as such vessels are not finally classed until they have been examined and found satisfactory on arrival at their service area.

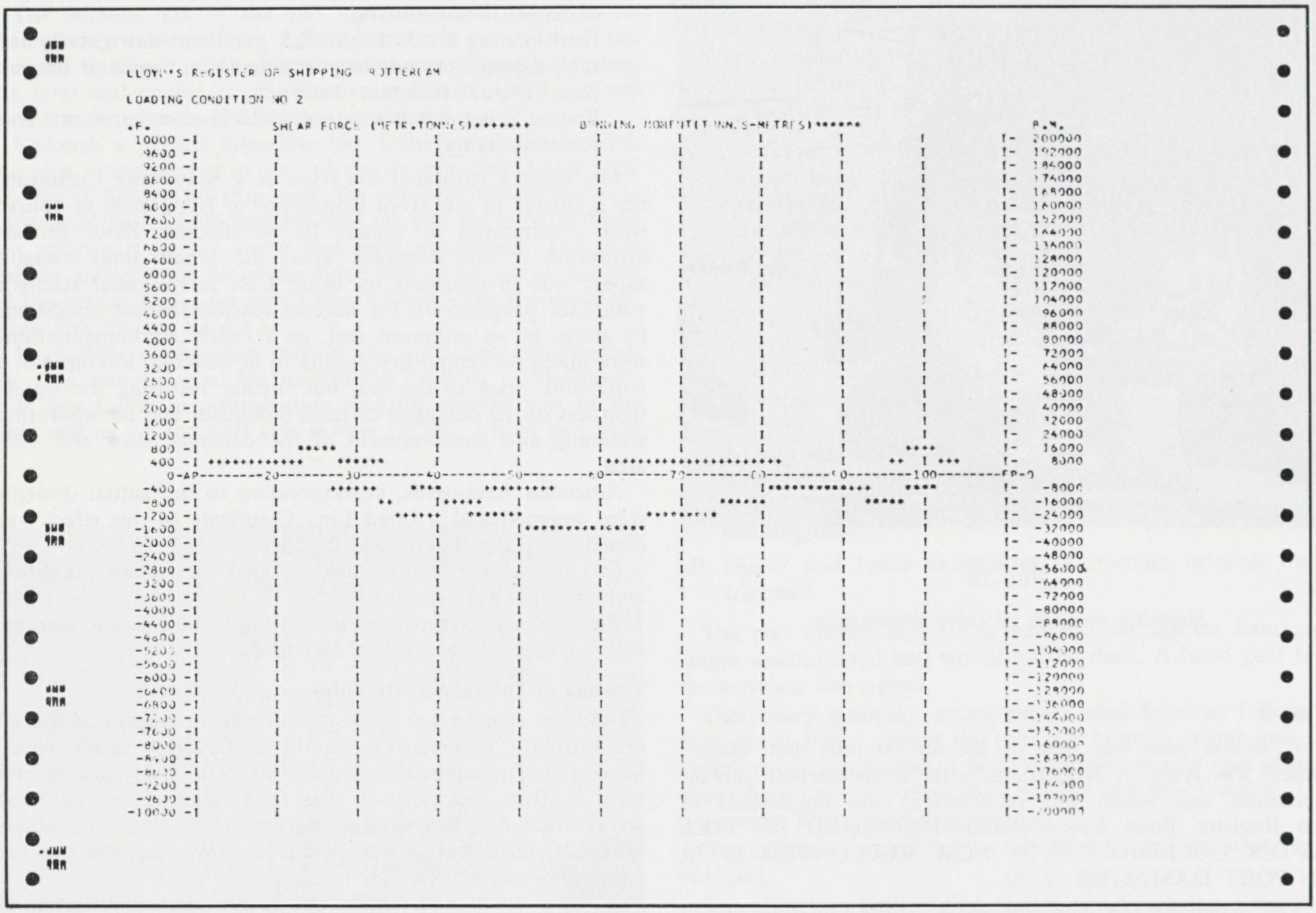


FIG. 19(a)

Computer print out.

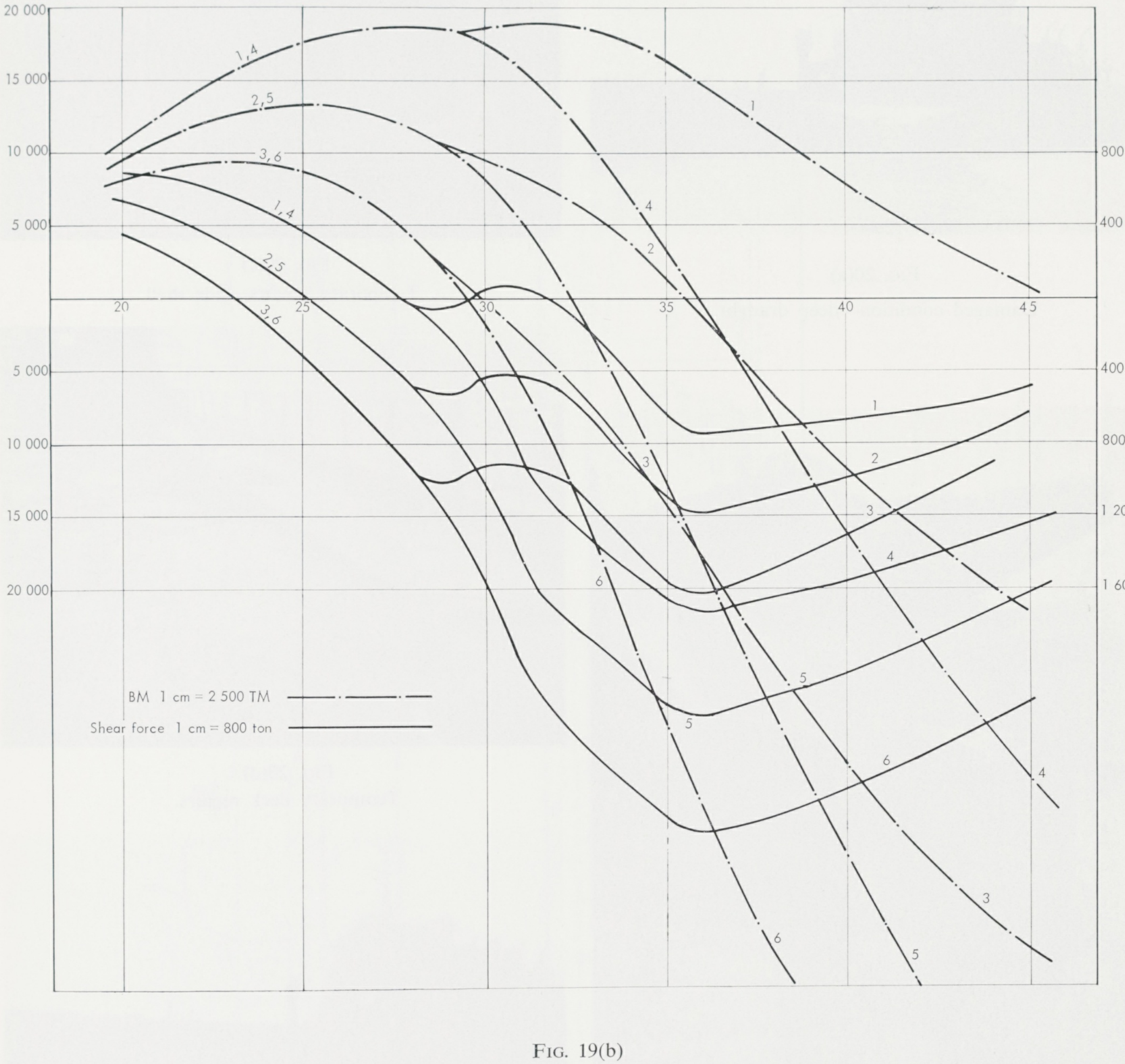


FIG. 19(b)
Curves.

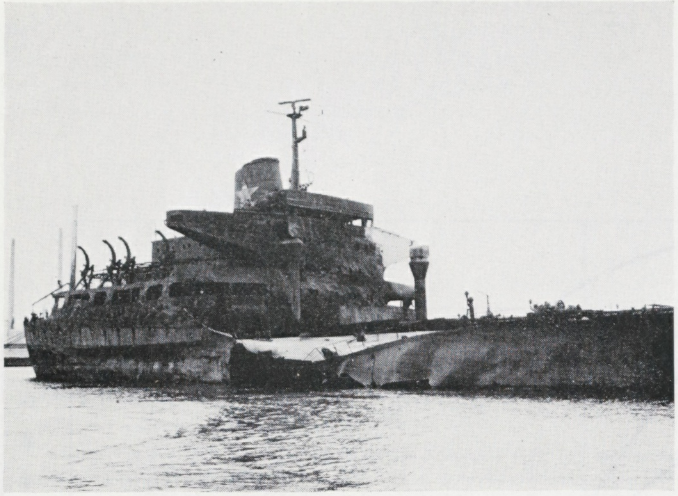


FIG. 20(a)
Damaged condition—deep draught.

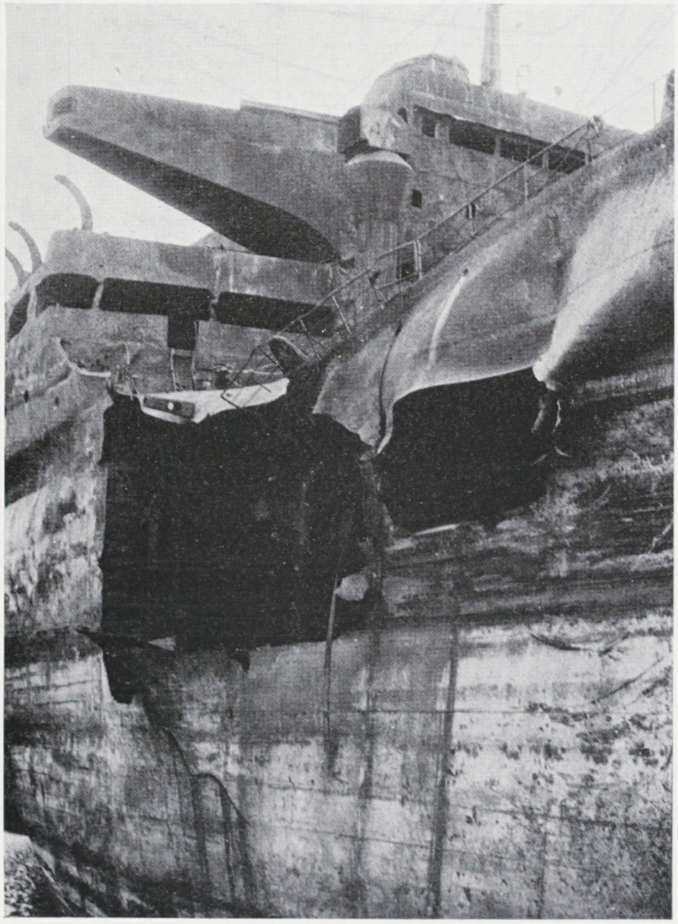


FIG. 20(b)
Damage—light draught.

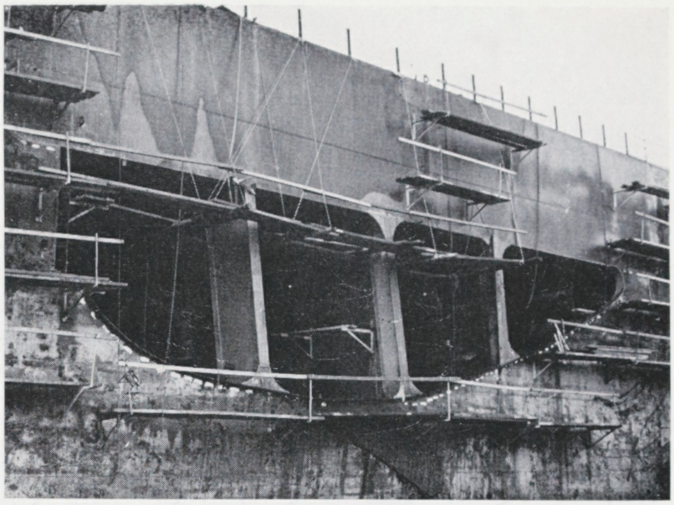


FIG. 20(c)
Temporary repairs—side shell.

FIG. 20(d)
Temporary deck repairs.

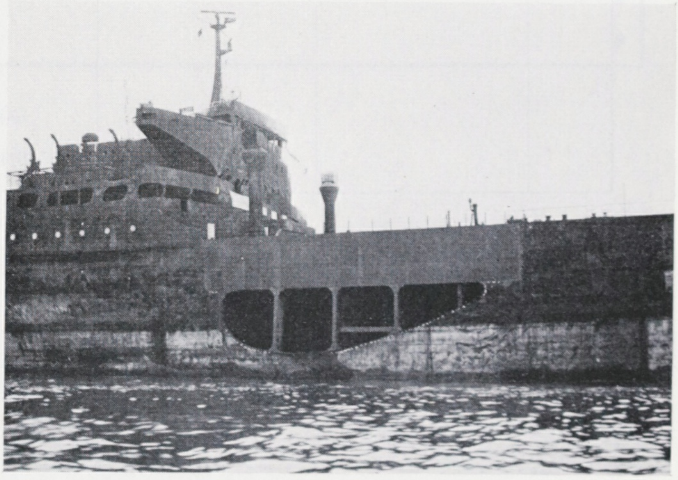
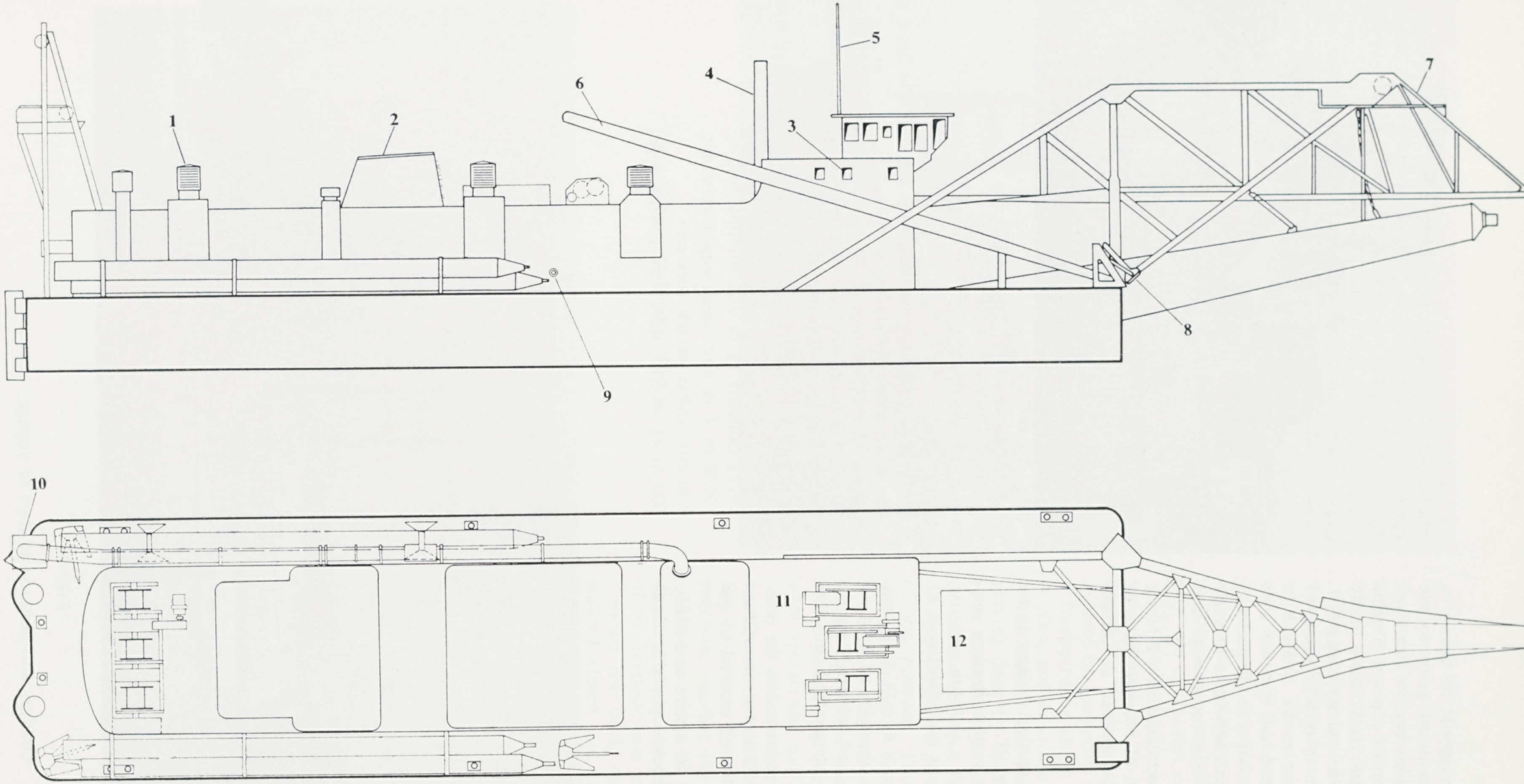


FIG. 20(e)
Temporary repairs completed.



1 Vents screwed down or blank flange fitted
2 Funnel covers fitted
3 Windows and lights fitted with steel covers
4 Derrick jib stowed and lashed
5 Signal mast to have all halyards and necessary shapes in position
6 Anchor booms to be secured
7 Ladder to be firmly secured
8 Emergency anchor fitted together with sufficient wire
9 Two bilge pumps fitted by towing contractor
10 Stern swivel swung inboard and effectively secured.
11 Cutter motors removed from suction ladder and stowed inside superstructure
12 Wood floor at end of ladder well removed and stowed inside superstructure
13 Two inflatable liferafts 6 person and line throwing apparatus fitted on board by towing contractor
14 A Norwegian type foghorn, 6 parachute distress signals and 3 red lights to be put on board by towing contractor

SEA VOYAGE PLAN

FIG. 21

The attention of owners and builders should be drawn to the fact that, if these aspects are considered prior to the building of the craft, certain modifications can be incorporated in the original design at a minimum of expense. Similar recommendations made at a later time could have fairly considerable financial consequences to the parties concerned. In such cases a towage condition plan is usually prepared showing all "not built-in" requirements to be fulfilled to obtain a Seaworthy and Load Line Certificate, together with the stability particulars in the voyage condition. Experience has shown that this information is of much assistance to those concerned with the subsequent preparation for towage and subsequent inspection.

The above procedure is especially recommended for floating cranes, dredgers and similar craft which of necessity have to be towed from one working area to another at certain intervals.

Case 3

A typical towage condition plan of a suction dredger to be prepared for ocean tow is shown in Fig. 21.

Fig. 22 shows a non-propelled, cutter-suction dredger prepared for towage on her own keel, with a skeleton crew on board, from the country in which she was built (Holland) to her service area in Brazil.

The cutter-dredger, dimensions 39 m × 9 m × 3 m was floating in the towing condition at a draught of 1,54 m forward and 1,84 m aft, the mean freeboard being 1,32 m.

Further particulars regarding the preparation of this dredger are:—

the ladder and control house were connected to the pontoon by means of electric welding; efficient struts, stiffeners and brackets were provided, all well secured to the deck,

an anchor was fitted aft connected to a wire and ready for immediate use in case of emergency, a portable diesel pump was placed on the deck with a connection fitted to the ship's main suction valve chest,

all sea connections not to be used were closed and hand wheels removed; all valves to be used by skeleton crew clearly marked and provided with notices.

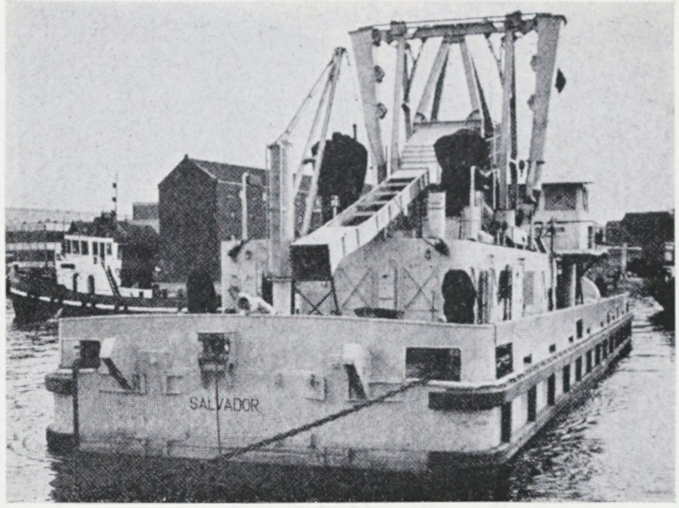


FIG. 22

Non-propelled dredger towed on her own keel.

The towing arrangements used by the 1200 b.h.p. tug consisted of:—

2×7½ fathoms 1¾ in dia. studlink bridle,

1×50 m 4 in circ. steel wire forerunner,

9 in circ. nylon stretch wire and

500 m 4½ in circ. steel wire towing rope.

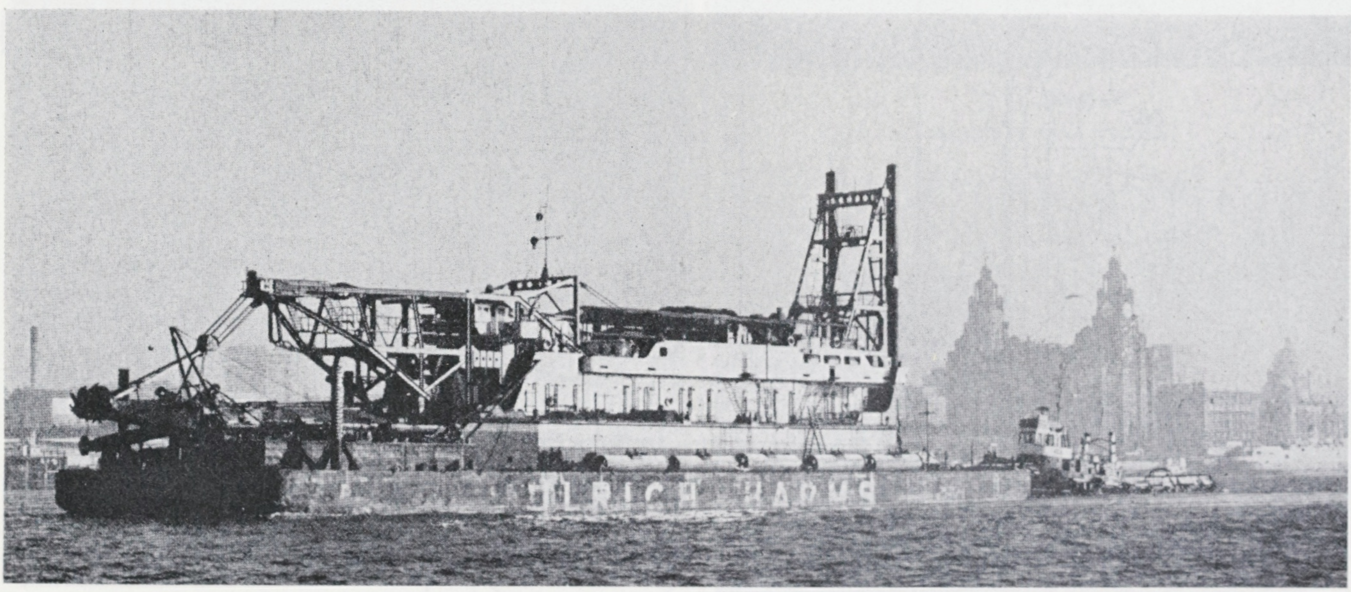


FIG. 23

Dredger and pontoon at start of voyage.

Case 4

To obtain the required stability range (45°) for another dredger, the bucket ladder had to be placed in the lowest position and all buckets and links had to be stowed in the hold.

The ship obtained a Seaworthy Certificate for the voyage Amsterdam–Gdansk, but departure was restricted to maximum wind force 5 on the Beaufort scale.

Case 5

A description of a typical transport by means of a towed unmanned pontoon is given below.

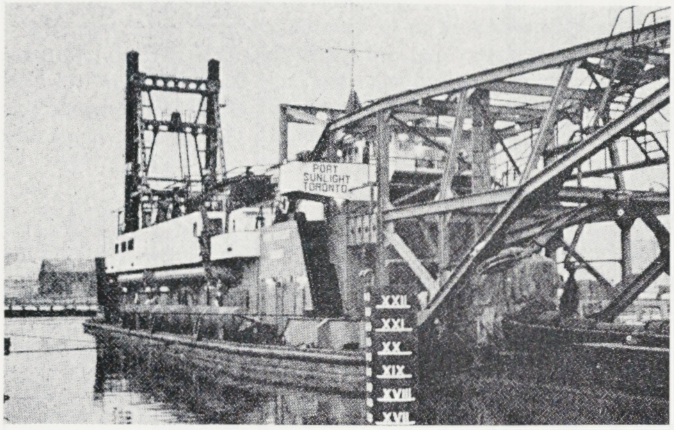


FIG. 24

View of dredger before raising.

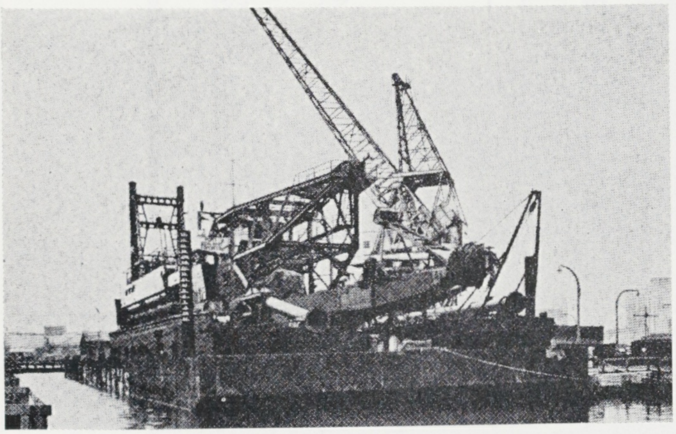


FIG. 25

Pontoon raised.

A 1200-ton displacement cutter-suction dredger with auxiliary craft, plant and stores, was to be towed on a large pontoon from the U.K. to West Africa where the dredger, supporting craft and equipment were to be used in carrying out an engineering/dredging contract.

The pontoon used had dimensions 76 m × 24 m × 4 m and was specially constructed to carry heavy deckloads on the flat upper deck. The subdivision and arrangement of sea valves, etc., was such that ballasting (by opening bottom valves) and de-ballasting (by means of compressed air) did not present any special problems.

Classification and Load Line Rules were fully complied with and certificates available.

The dredger (dimensions about 79,3 m × 15,2 m × 3,6 m) was prepared for the voyage in the normal way. As the freeboard and stability were, in this case, not critical due to the method of transport, she was floating on her own keel with a freeboard of about 0,46 m. The spud poles were secured in place not secured on the deck as is sometimes the case.

The sinking and loading operations were carried out in a graving dock by docking the pontoon on specially arranged rows of blocks after examination of the upper deck and fitting of the marker pipes which were necessary to ensure that the dredger would be placed in the correct position on the deck of the pontoon. These marker pipes were provided with draught marks to ensure the appropriate water depth above the deck of the pontoon. (They were kept in place during the voyage to be used again at the destination.) After inspection of the pontoon in dock, the valves and air pipes of all tanks were opened and the dock re-flooded, constantly sounding all tanks to ensure that the water level inside the tanks was equal to the water level in the dock. When the dock was full the doors were opened and the dredger positioned above the pontoon, together with some other small craft.

After reclosing the dock gate the dock was pumped out, checking at the same time that the water in the ballast tanks of the pontoon was level with that in the dock.

When the dock was dry all valves and air pipes were secured closed and then the complete unit was ready for refloating and the fitting of the required seaworthy fastenings of the deck cargo to the pontoon was started.

The refloating operation, carried out at destination, was effected by sinking the loaded pontoon at a suitable site so that she touched bottom at low water without submerging the deck. The craft were then floated off as the tide rose, the total difference between low water and high water being about 4,5 m.

The pontoon was raised by means of compressed air after the next low tide.

Case 6

As a further typical example of the use of pontoons for the transport of heavy contractor's equipment for which a Seaworthy Certificate has been issued, the stowage plan is shown of a pontoon, 914 m × 25,7 m × 8,1 m, loaded with about 3200 tons of equipment, varying from floating cranes to special steel pipes (Fig. 26). She was prepared for a voyage from Holland to Turkey. In this case the transport was manned and to a certain extent chains and wires were used for securing.

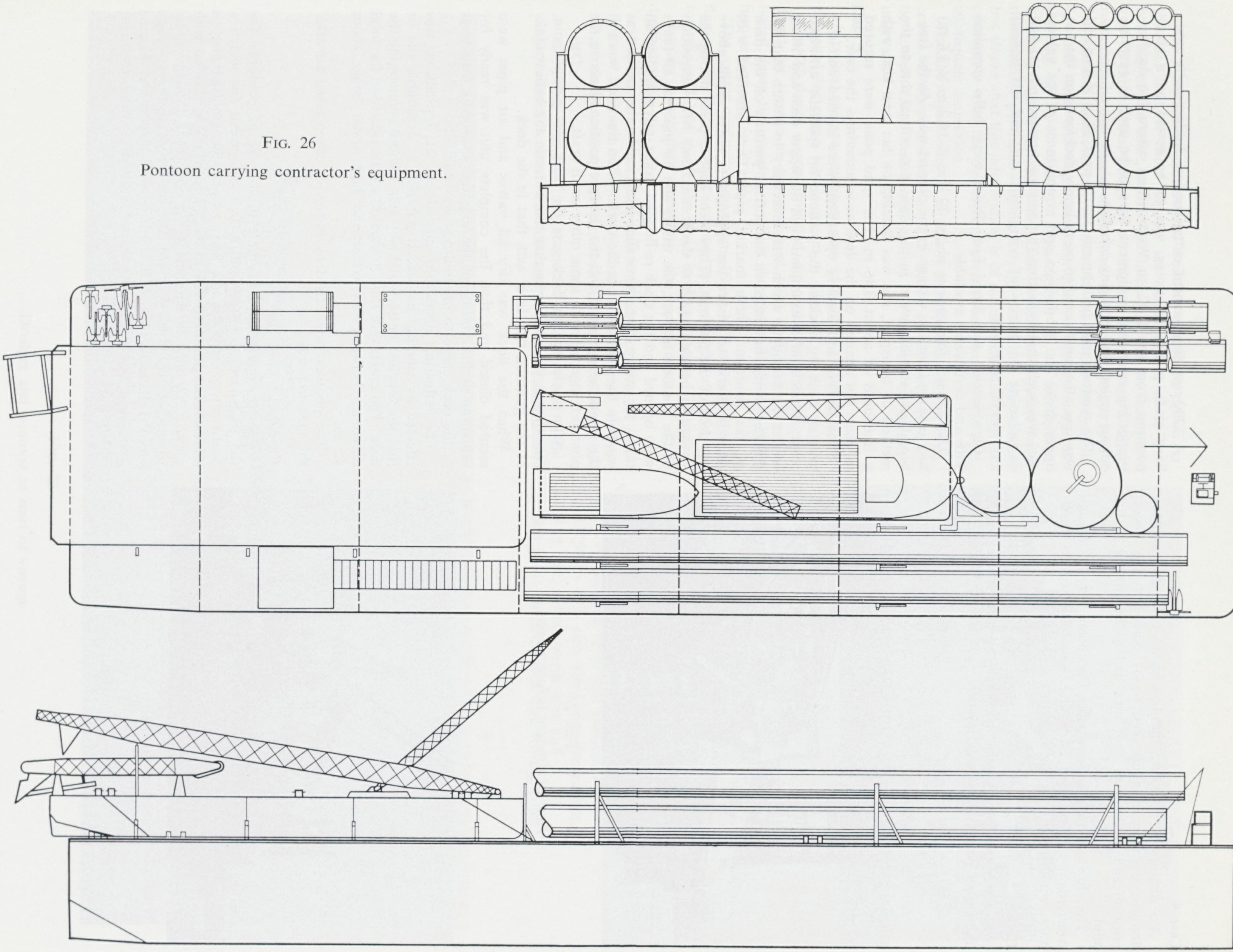


FIG. 26

Pontoon carrying contractor's equipment.

Case 7

Fig. 27 shows a large suction dredger together with dredging equipment prepared for towage Rotterdam–Setubal (Portugal), the total weight of cargo being approximately 3200 tons.

Case 8

The use of camel pontoons, such as that mentioned previously, sometimes lead to unique methods of fitting a cutter ladder from a pontoon into a dredger. For example:—

Contractors working with a large cutter-dredger in an area in the Mediterranean where no yard facilities were available had accepted a further contract in the same area. This necessitated the adaptation of the dredger, as the suction ladder originally fitted had to be replaced by a larger one and also two more barges had to be supplied.

The new ladder, approximately 34 m long was ordered and manufactured in Holland where the two omnibarges, dimensions 53 m × 8,5 m × 3 m, were also built.

To keep the delay of the dredger to a minimum by avoiding placing the dredger in drydock outside her working area, the ladder and barges were loaded (by means of a floating crane) on to a camel pontoon of about 70 m × 22,9 m × 5,2 m. On satisfactory completion of the towage survey, a Seaworthy Certificate for the contemplated voyage was issued.

At the place of destination, as already mentioned, neither docking facilities nor floating cranes were available, but by sinking the pontoon the refloating operation of the barges presented no major problem.

After finding a suitable berth the pontoon was flooded again in a slanting position as diagrammatically shown in Fig. 28, the ladder being secured in place on the pontoon. After manœuvring the dredger into the correct position over the pontoon the aft end of the ladder was lifted to enable the trunnions to be fitted. By connecting the dredger's own lifting tackle the ladder was then freed from the barge.

In this particular case the planning and preparation was such that the actual lifting operation and placing of the ladder was completed in about six hours. The dredger could be put into service again with her new equipment in a relatively short time, thus ensuring the required continuity of the dredging activities.

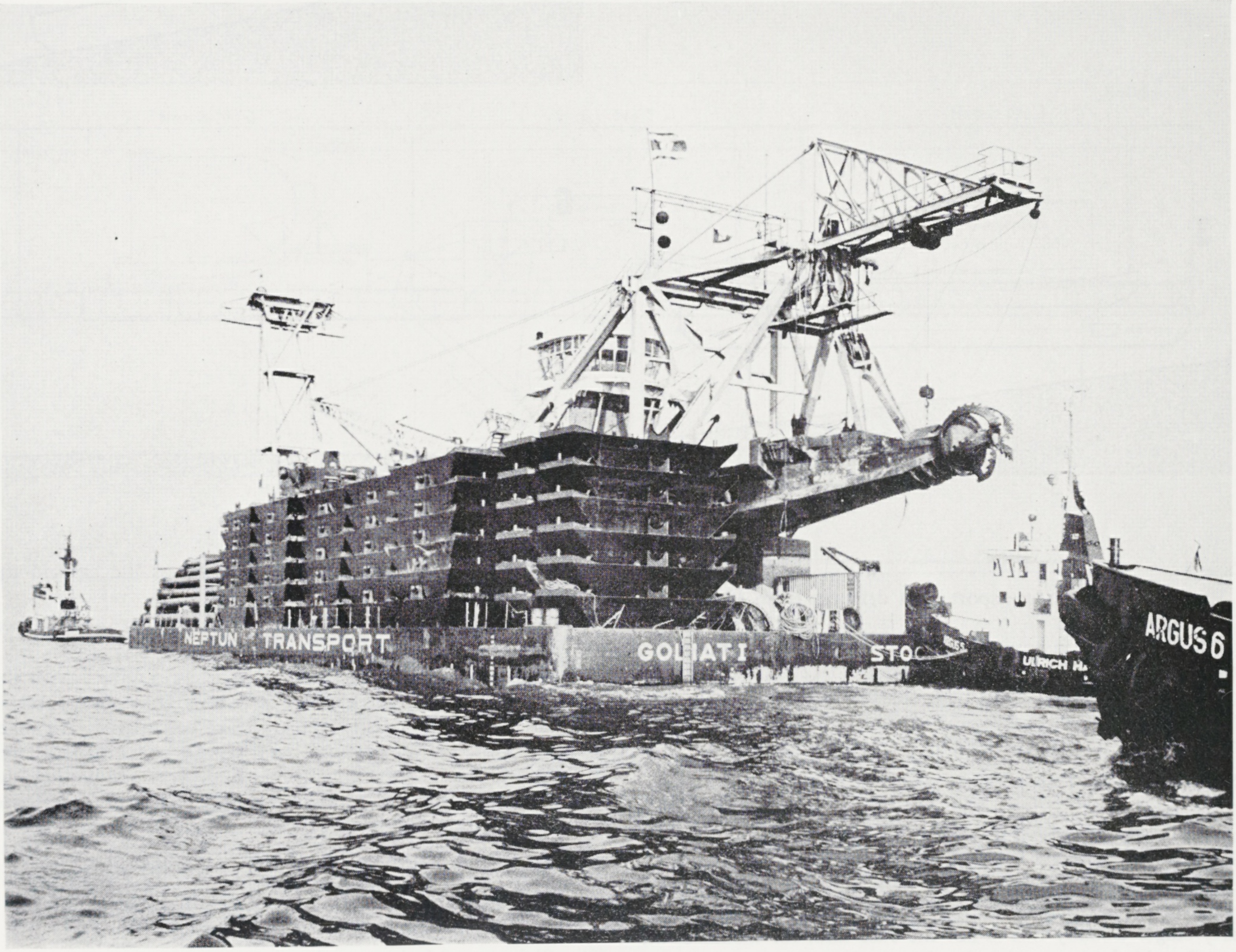


FIG. 27

THE "OPERATION CUTTERLADDER" IN PHASES

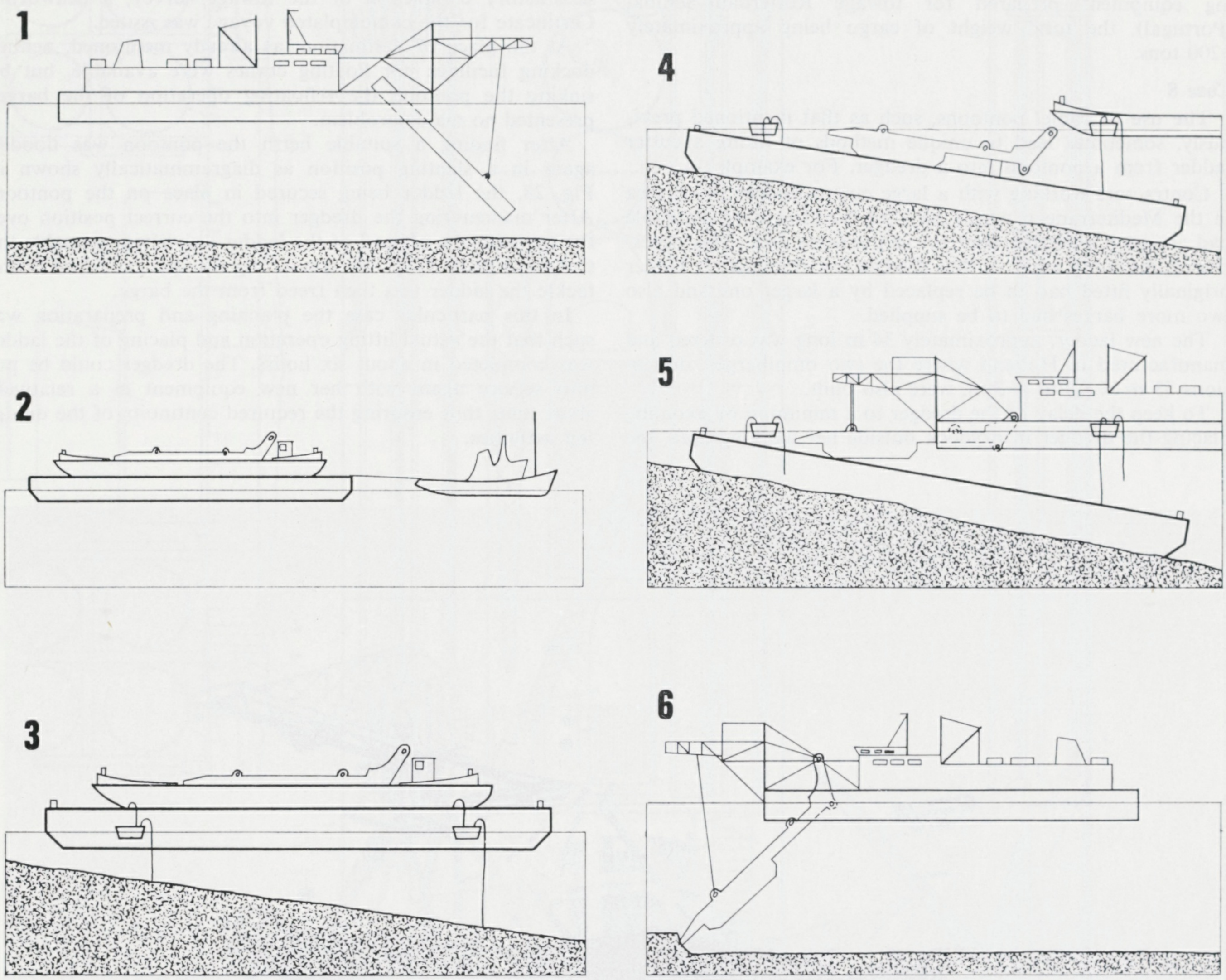


FIG. 28

Case 9

Fig. 29 shows the transport of a drill rig from Holland to Trinidad.

The drill rig with equipment (total weight about 3000 tons) was loaded on a pontoon, dimensions 76,2 m × 25,0 m × 4,9 m. Due to the large dimensions of the rig in relation to the pontoon, specially designed outriggers had to be fitted to the pontoon for transmission of the loads.

Cargo Ships with Exceptional Loads

The method of lashing and securing should be adapted to the ship's structure as well as to the shape and strength of the object to be carried.

It is of great benefit if such arrangements are discussed with the parties concerned and a stowage plan made at an early stage. Usually this is not the case and, for instance, the use of welded construction is often limited to attachments to the ship's structure. Even then non gas-free oil fuel tanks may give further problems when welding, as was the case in the example described.

Stability aspects do not usually raise any problems when loading dry cargo ships.

Emphasis is given to a good (and early) contact with the people responsible for loading in order that all problems associated with the particular cargo are considered. Arrangements can then be made which satisfy all concerned. In this situation proper advice from the Surveyor conducting the survey is, no doubt, appreciated, and may lead to well designed details and preferably welded construction.

Summarising, the main factors to be considered are:—

(1) distribution of loads,

(2) adequacy of supporting arrangements,

(3) efficiency of lashing and securing arrangements,

(4) initial stability and range of stability.

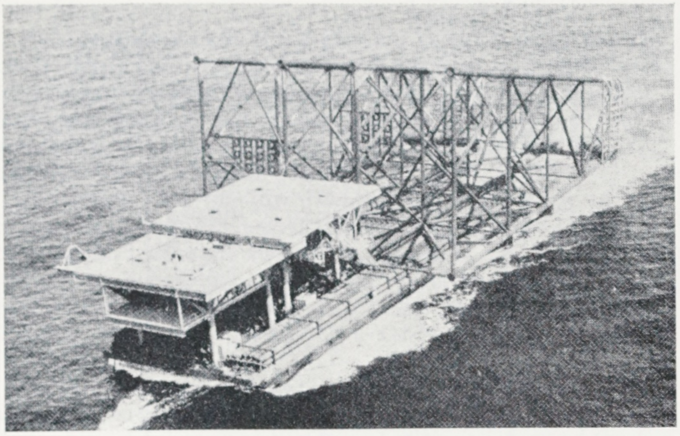


FIG. 29

Drill rig under tow.

A certain ingenuity is always required to adapt the form of support and/or securing arrangement to suit the loads and ship's construction.

Case 10

One of the cases dealt with was that of a normal cargo ship carrying heavy components of a nuclear power plant.

viz. a generator stator housing of 236 tons loaded in No. 1 hold,

a transformer of 254 tons in No. 2 hold and a reactor vessel of 365 tons in No. 3 hold.

The arrangements made for the carriage of the above loads were as shown in Fig. 30. The reason for loading the transformer in No. 2 hold was that the internal construction of this transformer could be adversely affected by accelerative forces. Further, the proper distribution of the loads to the ship's structure had to be considered when designing the supports.

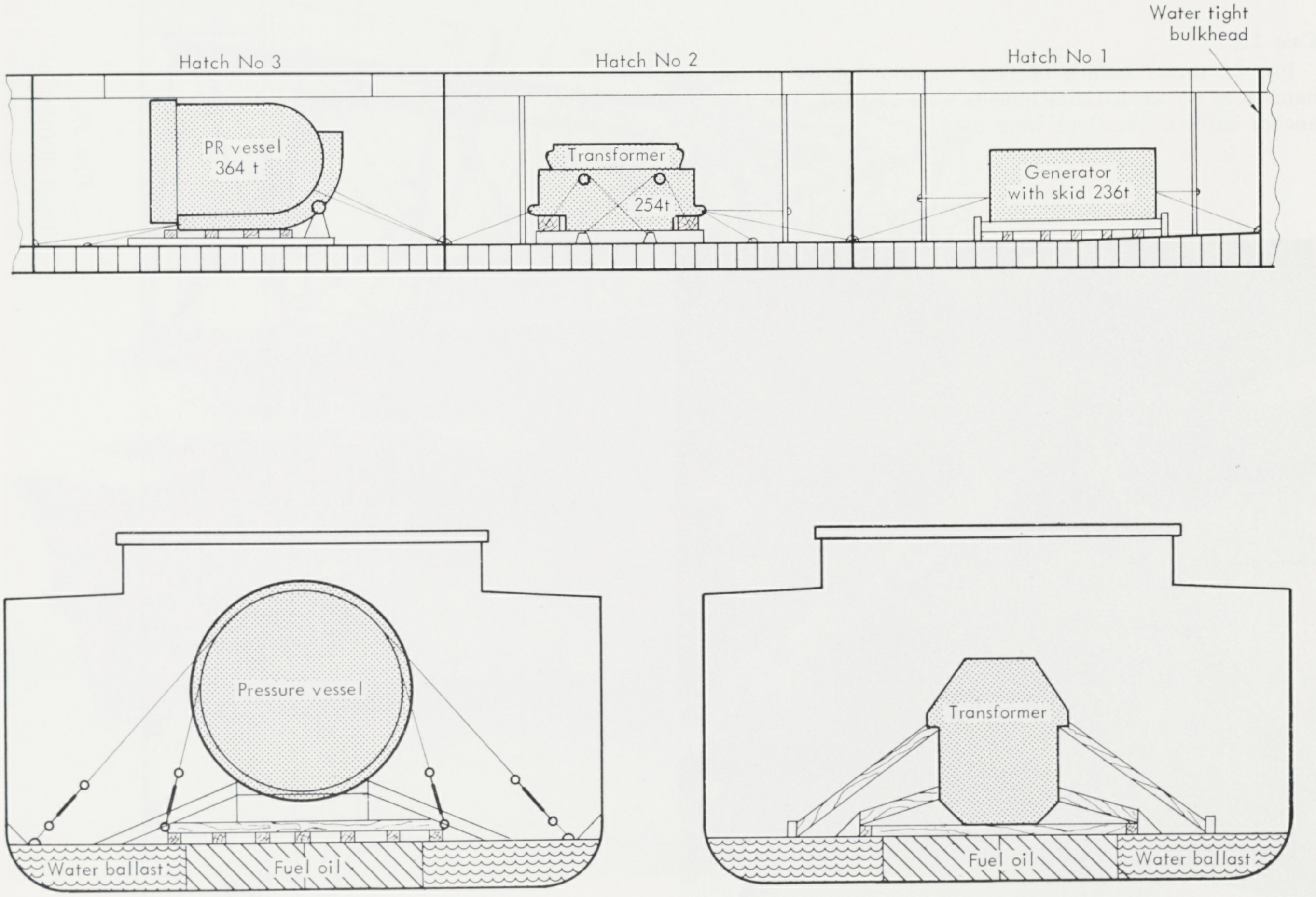


FIG. 30

Case 11

Fig. 31 shows the support made at the upper deck of a dry cargo ship to load railway carriages, the upper deck structure being provided with additional pillars in way of the bogies.

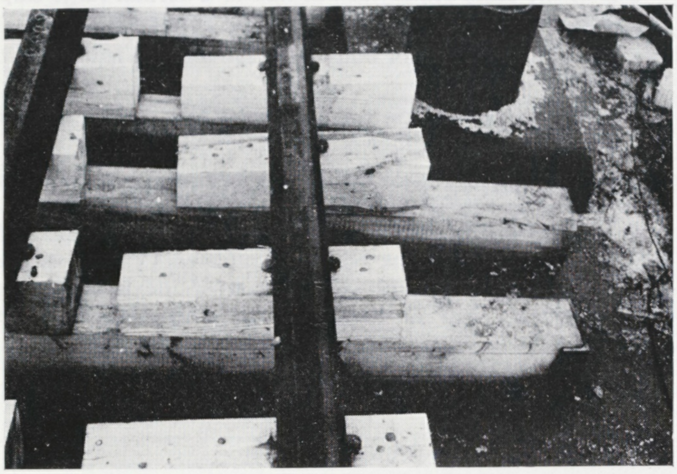


Fig. 31

Case 12

Fig. 32 shows lashing of large mooring buoys on top of hatches as no welded attachments were allowed. The existing anchor cable connections were used.

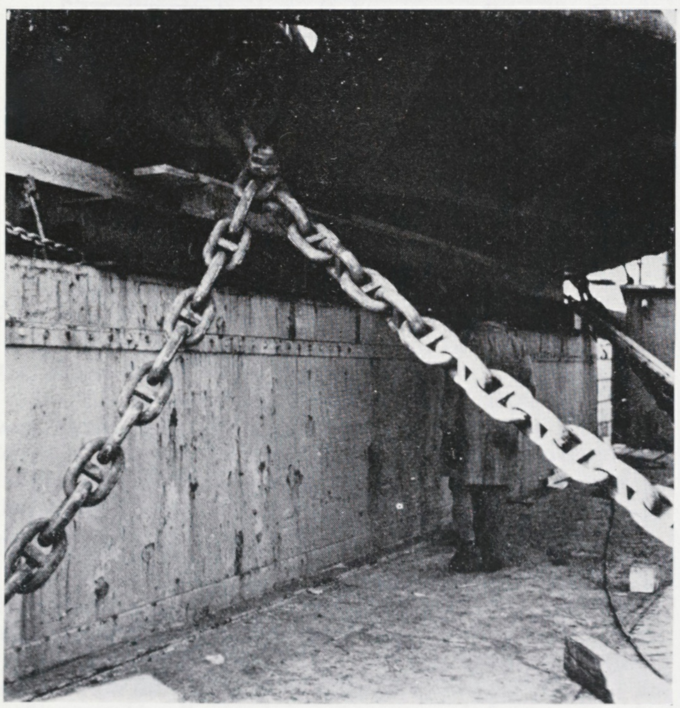


Fig. 32

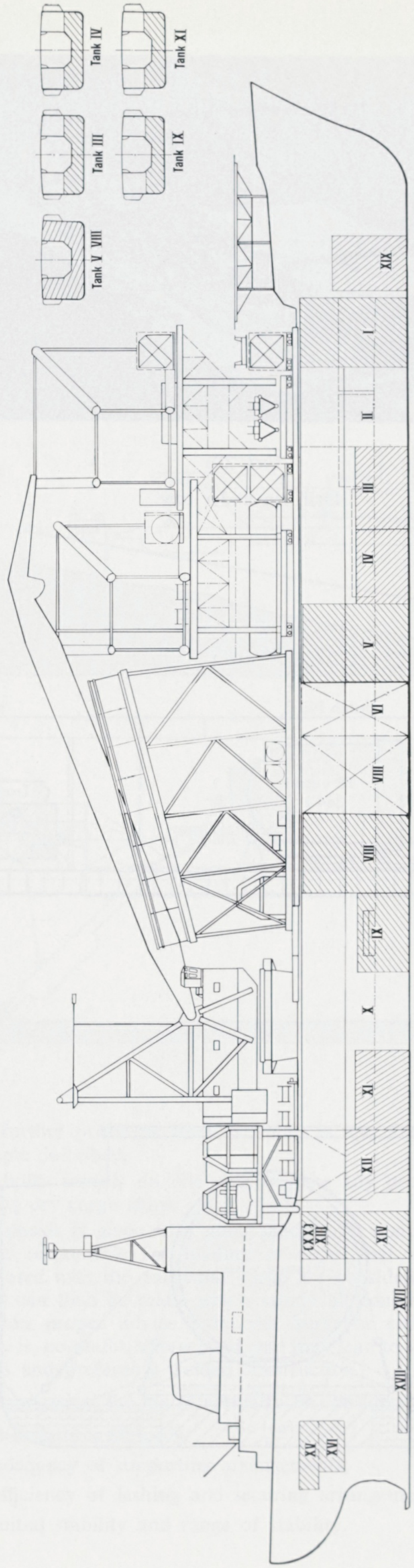


Fig. 33
Load distribution.

Case 13

An outstanding case of the carriage of deck cargo was the crane ship *Challenger,* loaded at Rotterdam with 7000 tons of steel structures comprising two four-pile production platforms and one eight-pile drilling complex, together with decks, separators, pumps, connecting bridges, submarine pipes, etc., destined for the Gulf of Suez.

The supervision, loading and securing of the whole of this construction so that it would withstand the dynamic forces to be expected took quite some time and effort.

Prior to departure, an inclining experiment was held to confirm the centre of gravity used in the stability calculations. The trip, taking 37 days via Cape Good Hope, was successfully completed.

Certain ships are especially designed to carry heavy loads, and the smaller types are usually designed as open shelter deck ships, loading their cargo on the second deck. When, however, large items have to be transported which can only be loaded on the upper deck, and no more deadweight capacity is available, the second deck space is left unloaded. In these cases stability is, of all problems, the most difficult one to tackle, and when considering the feasibility of the carriage of a large deckload on the upper deck, consideration of the stability aspects must have priority.

Case 14

One of the cases dealt with recently was the transport of a 375-ton reactor vessel in a 500 gross tons ship. The heavy load had to be loaded on the upper deck and was to be transported on crawlers weighing 85 tons each.

Stability calculations based on particulars submitted by the owners showed that the IMCO stability requirements (wind effect taken into account (*see* Appendix C) were met when loading the reactor vessel as close to the deck as possible and carrying the crawlers in the 'tween deck space. On this basis provisional approval was given for the proposed loading.

When supervising the loading care had to be taken to arrive at a loading condition at least equivalent to that of the preliminary calculations. On completion of the loading an inclining experiment was held to verify the calculated centre of gravity.

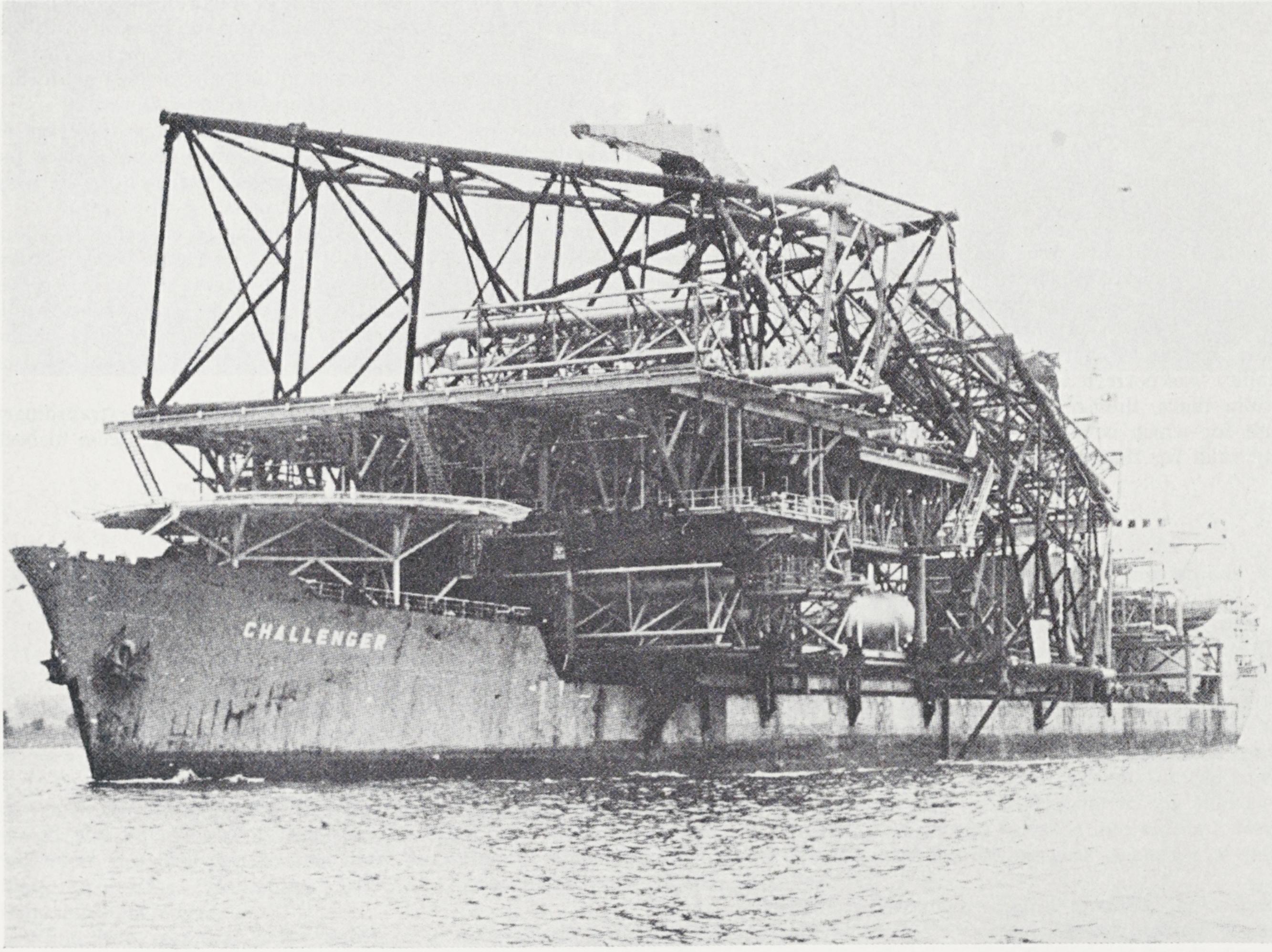


FIG. 34

Challenger loaded with 7000 tons of structures and equipment.

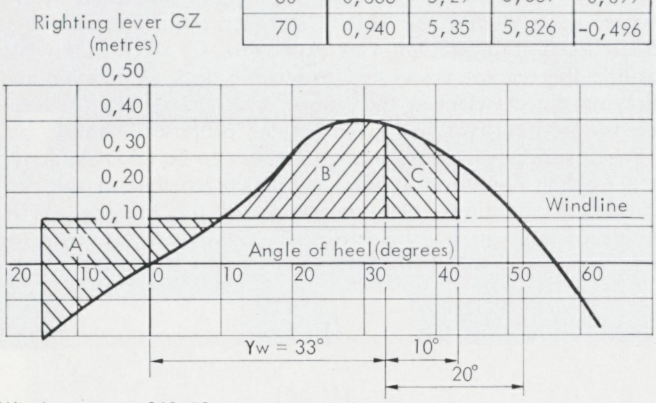
A = B

C = 3,8cm radians

$\overline{MG}$ - 0,80metre

$\overline{KG}$ - 6,20metre

Y	mY	NKmY	GKmY	$\overline{GZ}$
5	0,087	0,60	0,541	0,06
10	0,124	1,20	1,076	0,124
20	0,342	2,43	2,120	0,310
30	0,500	3,50	3,100	0,400
40	0,643	4,30	3,984	0,316
50	0,766	4,90	4,149	0,151
60	0,866	5,29	5,369	-0,099
70	0,940	5,35	5,826	-0,496



$$\frac{\text{Wind moment}}{\text{Displacement}} = \frac{242,82}{1\ 907} = 0,12\text{metres}$$

FIG. 35

A further difficulty to be overcome was that the unshipping of the load had to be done on the open sea where it was not possible to reinstall the crawlers underneath the reactor vessel. The solution reached was that the ship sailed to a port nearest to the final destination where the crawlers were refitted underneath the reactor vessel and the adverse influence on the stability was corrected by taking more ballast in the double bottom tanks, thus reducing the freeboard below the minimum for which condition new loadlines were assigned, but only valid for that particular short voyage.

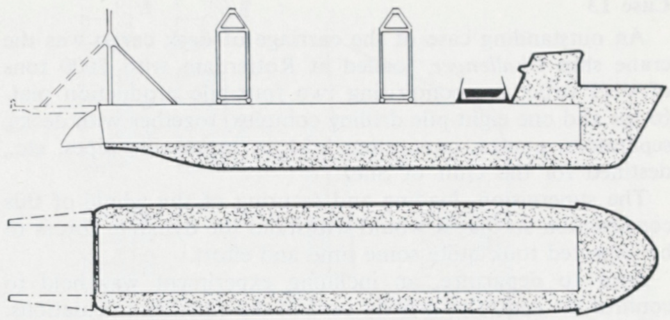


FIG. 36

Docklift 1

The statical stability curve for the arrival condition is given in Fig. 35.

The latest development of heavy load transport is represented by Van der Laan's *Docklift 1,* recently completed to Lloyd's Register Class.

This dockship is of multi-purpose design in that it is a self-propelled drydock, suitable for transporting, both on deck and in the holds, very heavy cargoes, including atomic reactors, cracking towers and components of offshore drilling platforms, as well as floating equipment, push barges, etc.

In addition to the advantage of safe and fast transport of heavy cargoes, the ship also offers dredging companies the possibility of transporting a larger variety of dredging material, including non-seaworthy units.

The *Docklift 1,* which has a carrying capacity of about 7000 tons, may also serve as a feeder for LASH-parts carriers, although it has not been specially built for that purpose. Moreover, a badly damaged ship can be transported by this unique vessel provided it fits into the dock, which is 88 m long and 12 m wide. Ships up to 1500 tons dwt. may be carried.

For rolling mobile equipment on and off, this extraordinary ship has a 8-m long, 12-m wide ramp, giving access to both deck and dock.

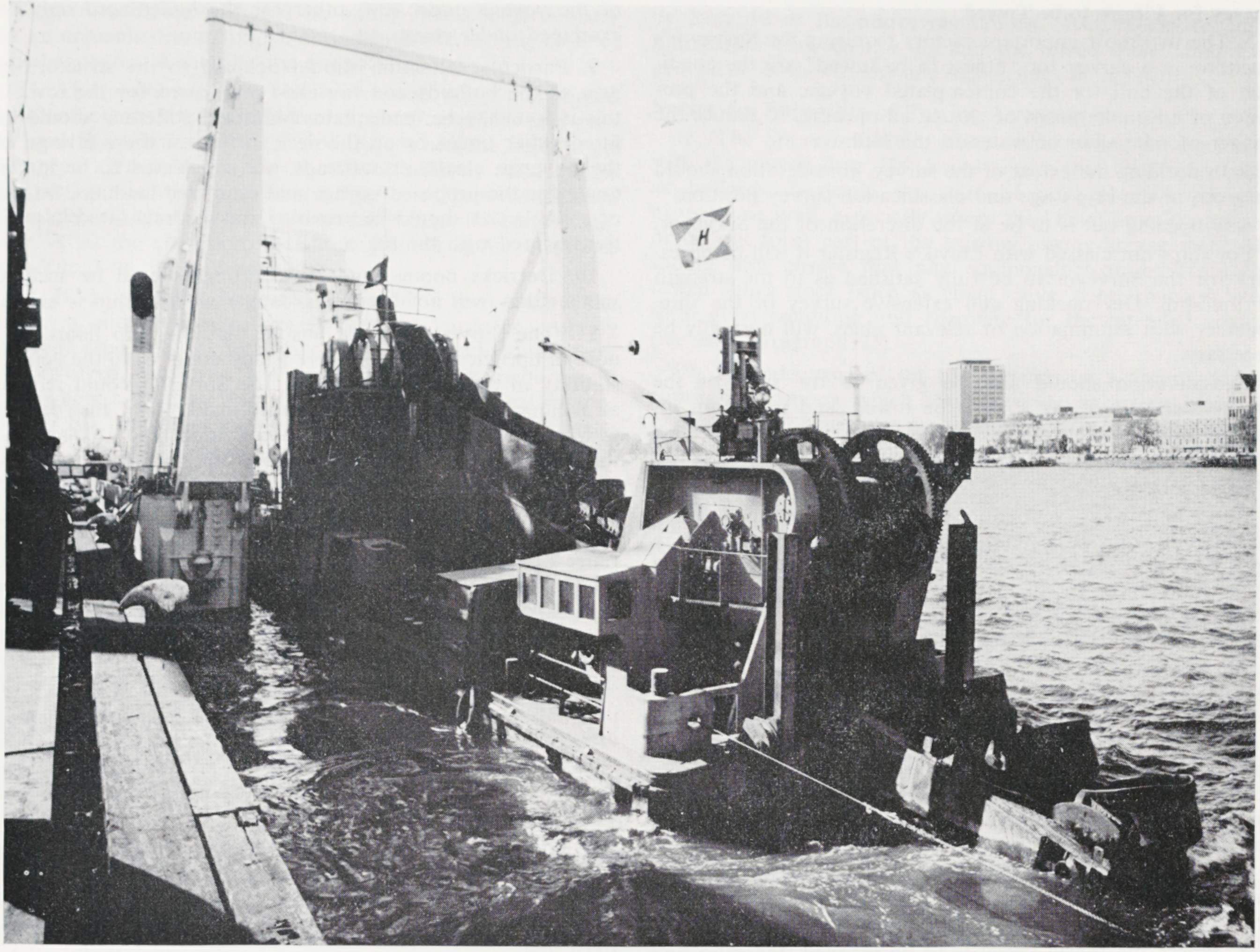


FIG. 37

APPENDIX A

REVISION OF INSTRUCTIONS TO SURVEYORS ON TOWAGE SURVEYS—PART II 1954 (ii)

1. It is the desire of the Committee that the technical services of the Society should be available to the shipping community to as great an extent as can reasonably be provided, and the survey of ships, barges, etc., to determine their fitness to proceed under tow, comes into this category.

2. These notes are issued for the information and guidance of the Surveyors in regard to these surveys. The items mentioned will not necessarily apply to all cases, and therefore Surveyors are expected to use their discretion in applying these instructions. This applies particularly to vessels of other than shipshape form.

While Surveyors may have doubts about undertaking work which is beyond their experience or the requirements of these instructions, it should not be overlooked that the experience of other ports is available through Head Office. In such cases full information must be forwarded regarding all those aspects of the tow which are covered by these instructions with English translation where relevant.

3. It is not possible to lay down hard and fast rules for towage arrangements as so many variables are involved. The tow may range from a westbound voyage of a floating dock across the North Atlantic to a short sea trip between two ports, where the sea conditions are likely to be relatively calm. There is the further point that some very experienced towing companies have their own preferred system for the towing arrangements, towline, and its attachment to the ship to be towed, and such factors should be taken into account. Nevertheless the condition of the towing gear is always of prime importance.

4. Head Office agreement should normally be obtained before towage surveys are carried out on unclassed ships, ships classed with other societies, floating docks, dredgers or other vessels of unusual form, but this agreement is not necessary in other straightforward cases on ships classed 100A1 without service restrictions.

Survey for Fitness to be Towed

5. The two most important factors requiring the Surveyor's attention in a survey for "fitness to be towed" are the condition of the hull for the contemplated voyage, and the provision of adequate means of closing all openings to reduce the danger of admission of water to the hull.

6. In deciding the extent of the survey, consideration should be given to the ship's age and classification survey position.

Any opening out is to be at the discretion of the Surveyor.

For ships not classed with Lloyd.'s Register it will be necessary for the Surveyor to be fully satisfied as to the strength of the ship. Dry docking and extensive survey of the ship, together with examination of relevant plans, will normally be necessary.

Consideration should also be given to the state of the underwater hull of the ship to be towed, and in certain instances when fouling is extreme, cleaning either in dry dock or by using underwater cleaning methods may be advantageous.

7. All hatchways, ventilators and air pipes are to be fitted and secured with "Rule" closing appliances, except where such openings are likely to be used if the towed vessel is manned by a riding crew. In this case the closing appliances for the vent and air pipes in use are to be stowed close to their respective openings for quick fitting.

All windows and side scuttles are to be closed, and their respective deadlights fitted and secured in position, except where these windows and side scuttles are to be used in a riding crew's accommodation. In this case the deadlights should be stowed near their respective windows and side scuttles. Outside doors giving access to accommodation spaces and companionways, other than the minimum required for the riding crew, are to be secured.

All tank top manhole covers are to be in place and securely bolted down. Watertight doors in hold, 'tween deck and engine room bulkheads are to be securely closed.

8. Where the towed vessel is to be manned, the bilge and ballast pumps, or pumps placed on board for the purpose, suction manifolds, and valves, should be in a satisfactory working condition with provision made to operate all the necessary suctions. Any other pumping arrangements required by the riding crew during the voyage, e.g. oil fuel transfer pumps for auxiliary machinery, should be examined and tested under working conditions.

If the ship's own pumps are to be employed and are electrically driven, the Surveyor is to satisfy himself that at least one of the ship's existing generators, prime movers and its starting arrangements, is of sufficient capacity for the intended load and is in good working order. If temporary pumps are placed on board, their installation and connections are to be to the Surveyor's satisfaction.

A general examination is to be made of the oil fuel tanks, pipes and fittings, also of the fire extinguishing arrangements, electrical circuits which will be in service are to be megger tested.

All inlets and overboard discharges not in use by the riding crew, and all inlets and overboard discharges in an unmanned tow, are to be secured in the closed position and tested for watertightness. Automatic Non-Return Valves should be checked to ensure their effective operation.

Any boiler to be used is to be surveyed if the boiler survey is six months or more overdue at the date of commencement of the voyage under tow, otherwise the boiler need only be examined under steam.

9. Particular attention should be paid to the structure in way of the bollards and fairleads to be used for the tow. If this is found to be inadequate, additional stiffening should be fitted either under or on the deck in way of these fittings. If the bollards, cleats, or fairleads, are considered to be inadequate for the proposed voyage and estimated loadings, fittings of suitable size should be provided and securely fitted in positions agreed with the tug master.

10. Derricks booms, and loose fittings should be secured so that they will not become a danger when a ship is at sea.

11. The Surveyor should ensure that the ship floats in a normal upright attitude. If there is any doubt as to the vessel's stability in the voyage condition, the Surveyor could request an inclining experiment, as described in Part 4 of Instructions to Surveyors, with the vessel in a condition ready to sail, and the resulting GM should be at least one foot positive. This, of course, gives no indication of the vessel's range of stability, but if the ship is prepared and found in a reasonable seagoing condition and floating at reasonable draughts fore and aft, the range of stability for calm to moderate sea conditions should be adequate. Normally if the ship was satisfactory in service in a ballast or load condition it will be satisfactory as a hulk unless there has been an excessive addition or removal of hull or machinery weights.

If the Surveyor is still not satisfied with the stability after inclining the vessel, Head Office should be consulted giving all the relevant facts. The Surveyor should ensure that where ballast water is carried, the tanks are pressed up so that, as far as is possible, free surfaces are eliminated, or kept to a minimum.

12. It is recommended that the draught forward for ocean voyages be not less than given in the following table. In order to reduce yawing, towed vessels of shipshape form should have a trim by the stern, or aft end of tow, when being towed stern first.

LENGTH	D.F.	TRIM
100 ft	3 ft	1′ 0″
200 ft	6 ft	1′ 9″
300 ft	8 ft	2′ 6″
400 ft	10 ft	3′ 0″

The amount of trim could vary according to the tug master's recommendations, for instance pontoon type vessels are normally towed on a level keel. Generally the trim should never be less than one foot for a ship length of 100 ft. As the ship length increases the trim should be increased to a value of about 0·75 per cent L at 400 ft and above. Intermediate values should be as shown in the above table. Trims greatly in excess of those quoted should not be permitted. If the vessel is to be ballasted or to have cargo retrimmed, to obtain the desired draughts, due regard should be paid to the distribution with respect to longitudinal strength. If tanks are ballasted they should be pressed up, and cargo should be properly secured in the holds. Other methods to control yawing of the tow should be discussed with the tug master. In an emergency a drogue may be used, but this greatly increases the drag of the tow. It is recommended that if the tow is to be manned, and is of unwieldy type, such as a dredger, drilling rig, etc., some form of drogue for use in emergencies should be carried.

Departure draughts should be boldly marked, particularly on an unmanned tow, to give an indication to the tug crew of whether water is entering the towed ship.

13. The position of the helm is also arbitrary and should be discussed with the tug master. In some cases it is preferred to have it set at between 15° and 20°. When the helm angle has been agreed, the rudder should be securely fixed in this position. If the vessel carries a riding crew, provision should be made to alter the helm during the voyage if found necessary. After the alteration, the rudder should again be able to be secured in the new position.

14. If the vessel to be towed is loaded or part loaded, the Surveyor should satisfy himself that the cargo is properly secured, especially if deck cargo or heavy individual items are involved. However, the owners should be made aware that, where a disabled ship is carrying cargo, the final responsibility for the secure stowage of cargo is theirs and not the Society's. Where, however, a towage certificate is required for a vessel to specifically carry a non-perishable cargo from one port to another, e.g. exposed deck cargo on a pontoon barge or other such vessels with low freeboard, these cargoes should be firmly secured to the deck by welded attachments of adequate scantlings to the Surveyor's satisfaction. This fact can then be recorded on the towage certificate.

15. The Surveyor should draw attention on the certificate to the need for sufficient fuel, boiler feed water, etc.—with a generous margin—for the intended voyage. The towage company should be able to advise the Surveyor on the duration of the tow—distance to be covered divided by speed of tow, plus a margin of say 100 per cent for a tow lasting one week, to 50 per cent for a tow lasting six weeks.

An estimation of amounts of fresh water, diesel oil, etc., is given by:—

Fresh water:

0·025 ton/man/day for washing and drinking.

Diesel oil for generators:

0·0043 ton/b.h.p./day.

Feed water:

To suit the boiler capacity in relation to equipment in use.

Provisions and cold stores:

This is the responsibility of towing company or agents with regard to the crew to be carried.

16. The anchors and cables should be in good order and ready for immediate use in an emergency when the towed ship is to be manned. The windlass must be at least capable of paying out, braking, and holding the anchor. It is not essential that the anchor can be hove up. If the steering arrangements are to be utilised, they are to be examined to ensure that they are fully effective (*see also* paragraph 13).

17. The Surveyor should check the navigation lights. These are to be as laid down in the "International Regulations for Preventing Collisions at Sea 1960" (*see also* MOT pamphlet "Survey of Lights and Sound Signals—Instructions to Surveyors"), viz. red (port) and green (starboard) side lights and a white stern light on the stern of the last vessel of the tow; no mast lights are to be carried. Provision should also be made for displaying the "not under command" lights and shapes.

Facilities should also be provided, when the vessel carries a riding crew, for the making of sound signals as laid down by Rule 15 of the above regulations. Also, means of communication between the tug and the towed vessel should be provided—both wireless and signal flags or lamps.

Survey for Suitability of Towing Arrangements

18. The Surveyor should discuss the towing arrangements with the towing firm. He should ensure that all fittings (such as bollards, fairleads, etc.) are of adequate strength and properly secured, especially where they have been improvised or do not form part of the existing towing arrangement. He should also ensure that any equipment required from the towed ship's stock (such as chain cable, rope, shackles, etc.) is in good condition and adequate for the intended voyage (*see also* paragraph 21).

19. The adequacy of the tug depends on a variety of circumstances among which should be its operating limits. It may originally have been designed as a harbour tug, or coastal tug, and the intention may be to use it outside the sphere of its original design. Unless in exceptional and clearly defined circumstances, this should not be permitted. For a normal shipshape form of tow, the towing speed in fair weather should not be less than about six knots, and for a floating dock about three or four knots. Using the foregoing speed with a shipshape form, an approximation may be made of the towed vessel's resistance and hence the required power of the tug.

For a tug of normal hull form the required b.h.p. would be:—

$$\frac{\Delta^{\frac{2}{3}} \times V^3}{120}$$

where Δ is the displacement in tons of the towed vessel,
V is speed of tow in knots.

For a tug of hydroconic form, this value of b.h.p. should be multiplied by 0·80.

For a tug fitted with a Kort nozzle, the value of b.h.p. should be multiplied by 0·74.

For resistance of non-shipshape forms, H.O. should be consulted.

Where a Surveyor is asked to verify the towing capacity of a tug, careful consideration should be given to this matter, and generally, reference should be made to Head Office. In calculating the b.h.p. the actual proposed towing speed should be used. The quoted b.h.p. of the tug should be carefully examined. For tugs classed with the Society this is recorded in SRL Appendix. For tugs not classed with the Society the Surveyor should ensure that the quoted horsepower is for the main propulsion machinery only, and does not include power for auxiliaries.

20. It is assumed that the ship is to be towed ahead. When the tow is to be by the stern, the required b.h.p. of the tug should be multiplied by 1.2. Draught and trim should be similar to the ahead condition with the tow trimming aft with regard to direction of tow. Special care to be taken in the examination of bollards, fairleads, etc.

21. The minimum breaking strength of the tug's tow rope should be of the order of four times the maximum pull of the tug employed. For lower factors of safety Head Office should be consulted. The breaking strength of the various tow ropes can be obtained from P.9 of the Rules. The towed ship's towing rope generally may be found adequate for this purpose

(*see also* paragraph 22). The maximum tow rope pull (bollard pull) for tugs of normal form is approximately $\frac{\text{b.h.p.}}{77}$ or $\frac{\text{b.h.p.}}{(D)^2}$. For tugs of hydroconic form bollard pull may be taken as approximately $\frac{\text{b.h.p.}}{61}$ and for tugs fitted with Kort type nozzles bollard pull is approximately $\frac{\text{b.h.p.}}{57}$ where D is the propeller diameter in feet.

22. The towing connection should be made according to the circumstances and in close co-operation with the tug master. Generally, but depending on the tug master's requirements, for a deep sea tow, two lengths of cable on each side should be provided, either by the tug or from the towed vessel's own equipment, to form a bridle with fishplate connection at the forward end. Where a towed vessel's own equipment is to be used, this should be subjected to very careful examination to ensure that it is in good order. On old vessels where the equipment may be suspect, it is recommended that the vessel's own tow rope or hawsers should not be used for a deep sea tow. A further length of chain cable may be attached between the fishplate and the towing hawser to act as an intermediate "spring". The legs of the bridle must be of equal length and a tripping rope/wire connected to the fishplate to facilitate heaving in and recovery of bridle aboard the tow.

The bridle should be connected to the tow by padeyes and/or heavy towing bitts. Normally the bridle chain should be led in a figure eight about the bitt and the bitter end shackled to the padeye. If no bitt is used but the cable is connected direct to the padeye, a back-up wire should be fitted. This is led from the chain adjacent to the padeye to a cleat or bollard (of substantial strength) further aft as a safety measure in case of failure of the padeye. The back-up wire should consist of several passes of wire, the combined strength of which is to be at least equivalent to that of the towing hawser. Means are to be provided for setting up this wire and the ends securely fixed with at least three clips.

Where more than one vessel is to be towed by one tug, each towed vessel should be on a separate wire direct to the tug. Only in cases of very short tows in sheltered waters would the Society depart from this procedure.

Means are to be provided to prevent the bridle chain from jumping off the top of the bitts and where the chain passes through a fairlead it should be securely wedged to prevent chafing or surging. The size and condition of the towing hawser should be checked. Where the towed vessel is unmanned, a towing pendant of size equivalent to the towing hawser should be securely fastened to the after deck and trailed over the stern. Also, where the tow is unmanned, boarding ladders should be securely fixed to both port and starboard sides of the vessel. The towed vessel should carry mooring ropes sufficient in number, size and length. For coastal towing, similar arrangements should be made, except that the chain bridle may not be required on a smaller tow and the chain intermediate spring may be dispensed with.

23. If the duration of the tow is expected to be of some length, consideration should be given to disconnecting the shafting from the main engines so that the propellers will trail and thereby reduce their drag, but this should only be done in consultation with the tug master.

24. The Surveyor should advocate the use of a riding crew wherever possible, particularly on an ocean tow, except on small vessels. In the latter case, provision should be made for the tug crew to make examination of the tow under favourable weather conditions, e.g. provision of suitable boarding ladders, etc., attached to the side of the towed vessel.

Certificates

25. If the proposed towage is in any way connected with a claim to the underwriters, the Surveyor should refer the ship's representative to Lloyd's Agent in order that the Surveyor's standing in the survey may be clearly established. The Surveyor should take account of the requirements of the appropriate association, the London Salvage Association, the U.S. Salvage Association or the Norwegian Underwriters, where applicable.

26. Comment on the towing vessel should be restricted to its name and stated power; the condition of the tug's hull, main engines, towing hook, etc., should be excluded unless the owners of the tug make a request to have this included.

27. Load Line Regulations, as applicable, should be observed, and where a riding crew is carried. Safety Regulations (L.S.A., etc.) should also be observed. Any other statutory or national authority regulations which may be relevant should be adhered to.

28. We have been requested by underwriters to endeavour to issue Towage Certificates in as uniform a pattern as practicable. A sample outline of a Towage Certificate is attached and this should be prepared in appropriate cases on Form Rpt. 10. The Surveyors will note the suggested heading of "Seaworthy Certificate (Fitness to be towed)".

A copy of all Towage Certificates issued should be sent to London for Head Office information.

29. The certificate should be completed as follows:—

(a) *Paragraph 1.* This should contain the normal recital of the facts of the case.

(b) *Paragraph 2.* This paragraph should state clearly the voyage contemplated and any restrictions on the date of sailing. It should also contain (if necessary) a statement that the voyage should be undertaken in "favourable weather conditions". In no circumstances should the Certificate mention "a favourable weather forecast".

(c) *Paragraph 3.* This should clearly indicate whether only the machinery class, or the class of both hull and machinery is suspended for the voyage. In the case of a classed ship which is being towed because of defective propelling machinery, during the tow there should be at least a riding crew, and all essential auxiliary machinery should be in a satisfactory working condition including the refrigerating machinery when refrigerated cargo is carried. In such cases Certificates should state that the class of the propelling machinery is suspended for the duration of the voyage.

(d) *Paragraph 4.* This should contain a clear statement as to whether the towage arrangements have been examined or not. Details of the towage arrangements should be given when required, including the name and b.h.p. of the tug. In general the Surveyors are to advocate the issue of a "Fitness to be towed" certificate which includes the towing arrangements. In general, when requested, the Society will be prepared to include the survey of the towing arrangements insofar as it covers the towing gear and its attachment to the towed ship.

Where the Surveyor is not completely satisfied with the towing arrangements, including the choice of towing vessel, a statement should be made excluding the Society's responsibility in this matter.

(e) Where the Surveyor has reason to suspect the wisdom of carrying certain cargoes, or is apprehensive about their stowage, a statement expressly excluding the Society's responsibility from this aspect should be made.

30. Fees should be commensurate with the services rendered.

LLOYD'S REGISTER OF SHIPPING

SEAWORTHY CERTIFICATE

(Fitness to be Towed)

Port..

Date..

1. **This is to Certify** that at the request of (Recital of facts, e.g. party requesting survey, name of ship, whether seen afloat or in drydock, extent of survey and reason for inspection, recommendations made and carried out).

2. In my opinion this vessel is fit to be towed in her present (ballast, loaded, etc.) condition from..................
to...

3. The *class of the ship / *machinery class is suspended for the duration of the voyage.

4. *The towage arrangements have also been examined and are satisfactory for the voyage.

OR

*The foregoing examination does not include the towage arrangements which are entirely the responsibility of the Towing Company and the Owners.

5. *This Certificate does not cover the stability of the ship, which must remain the Owners' responsibility.

6. *The ship is not classed with Lloyd's Register of Shipping.

(Signed)

Surveyor to Lloyd's Register of Shipping

This Certificate is issued upon the terms of the Rules and Regulations of the Society which provide that:—

"The Committees of the Society use their best endeavours to ensure that the functions of the Society are properly executed, but it is to be understood that neither the Society nor any Member of any of its Committees nor any of its Officers, Servants or Surveyors is under any circumstances whatever to be held responsible or liable for any inaccuracy in any report or certificate issued by the Society or its Surveyors, or in any entry in the Register Book or other publication of the Society, or for any act or omission, default or negligence of any of its Committees or any Member thereof, or of the Surveyors, or other Officers, Servants or Agents of the Society."

* Delete according to circumstances.

N. Rpt. 10

APPENDIX B

STABILITY

Recommendations made by IMCO, with regard to the stability of cargo and passenger ships of less than 100 m in length, include the following criteria: —

(a) the area under the righting lever curve (GZ curve) should not be less than 0,055 m.rad up to an angle of heel of 30° and not less than 0,09 m.rad up to an angle of heel of 40° or, if this is smaller, the angle of flooding, i.e. the angle at which openings in the hull, superstructures or deckhouses which cannot be closed weathertight are immersed.

In addition the area under the righting lever curve between the angles of heel of 30° and 40°, or between 30° and the angle of flooding if this angle is less than 30°, should not be less than 0,03 m.rad.

(b) the righting lever GZ should be at least 0,02 m at an angle of heel equal to or greater than 30°.

(c) the maximum righting arm should occur at an angle of heel preferably exceeding 30° but not less than 25°.

(d) the initial metacentric height GM_0 should not be less than 0,15 m.

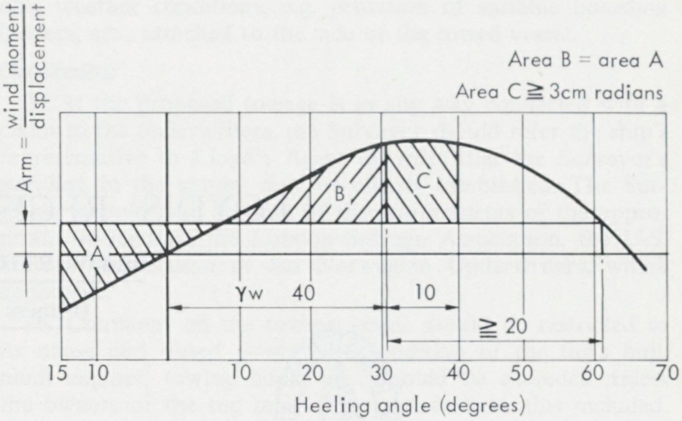


FIG. 38

Stability curve.

APPENDIX C

NETHERLANDS SHIPPING INSPECTORATE

Amended Directives Concerning the Effect of Wind

(free translation)

For the calculation of the pressure due to wind the wind pressure to be assumed is 60 kg/m² up to a height of 5 m above the waterline and 100 kg/m² above this height (i.e. wind forces 11 and 12).

For the calculation of the wind-moment, the moment of the wind force is to be taken about the centre of lateral area of the underwater portion of the ship.

For the calculation of the angle of inclination due to the effect of this wind-moment, an initial list to the windward side of 15° is assumed whilst the lever due to the wind-moment $\left(\dfrac{\text{wind-moment}}{\text{displacement}}\right)$, is kept constant for all angles of inclination.

The following criteria have to be met.

1. The actual angle of inclination due to the wind-moment φ_w should be a maximum of 40°.
2. The increase of the dynamic stability above the wind-line between the angles of inclination φ_w and $\varphi_w + 10°$ should not be less than 3 cm radius (area C).
3. The range of the curve of righting levers measured on the windline should be at least $\varphi_w + 20°$.

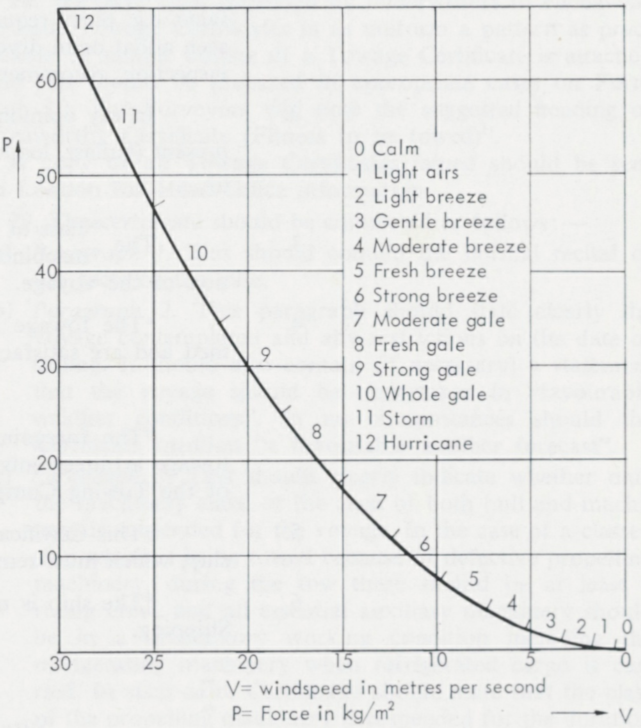


FIG. 39

BIBLIOGRAPHY

(1) Small Sea-Going Craft and Vessels for Inland Navigation. Ir. A. Roorda, M.I.N.A., Ir. E. M. Neuerburg.

(2) Proceedings of the First International Tug Conference. Thomas Reed Publications.

(3) Proceedings of the Second International Tug Conference. Thomas Reed Publications.

(4) Tugs, Towboats & Towing. Edward M. Brady.

Printed by Lloyd's Register of Shipping at Garrett House, Manor Royal, Crawley, Sussex, RH10 2QN, England

Lloyd's Register Technical Association

SOME NOTES ON A LARGE TANKER MACHINERY INSTALLATION—STEAM TURBINE

Douglas Hague

Paper No. 6. Session 1972-73

Hon. Sec. C. Cummins
71, Fenchurch Street, London, EC3M 4BS

SOME NOTES ON A LARGE TANKER MACHINERY INSTALLATION—STEAM TURBINE

CONTENTS

"They that go down to the sea in ships, that do business in great waters".

1. Synopsis

Due to the Technology Explosion still inundating us with excessive verbiage it is intended, using sketches and photographs and the minimum of words necessary to cover this large subject to attempt a description of the title in relation to First Entry surveying work and give a word picture of a part of newbuilding life. Should this methodical attack on the initially bemusing requirements of a First Entry Report—Machinery Installation, also manage to diminish, even if by only one decibel, the accoustic warfare that is inherent in the Surveyor's family life during the first six months of a "Posting" to a port dealing with newbuildings, then it will be felt that some small measure of success will have been achieved with the contents of this Technical Association paper.

2. General Introduction

The fundamental aim of the paper is to enable an Engineer Surveyor originating from a port dealing with repair, C.S.M. and other facets of the Society's work, but having very little F.E. experience, to be able to carry out or pick up the threads of the machinery installation—main and auxiliary, with respect to a large steam turbine tanker of the 250 000 to 500 000 tons dw class.

It may be queried "Is it necessary?"

In reply it is offered that it is, should, on transfer, one be deposited in the half complete machinery space of a large s.t. tanker. The general idea being to pick up the threads and progress the installation examinations and F.E. report to completion. It would be reasonable to suggest that it is quite a "deep end" to be pushed into.

It will be attempted to show the reasons for carrying out the examinations that are to follow in respect of:—

(a) *Rule Requirements:* Due to shipyards being production-time conscious, one must be very specific about rules without having too much time to ponder, especially in the case of a yard with seven weeks' building time and three weeks' fitting-out time, giving five V.L.C.C's every year.

(b) Common sense and past experience as reproduced in the Instructions to Surveyors.

(c) The Rules, Instructions to Surveyors, Circulars and Technical Association Papers are complementary for the full analysis, installation and documentation of a F.E. Machinery Installation.

There are various "asides" interspersed throughout the theme concerning problems that have arisen during construction of installations and their problematic remedies, present problems relative to advancing survey requirements and progressive installation developments. It is with these cases which may be slightly controversial that it is hoped to retain the interest of another section of colleague who, in the written discussions may be able to throw more light on these topics and so allow the discrepancies to be reduced. A few of the cases are: (a) Split Tillers, does the grip or the key take the torque load, (b) emergency alternators may be of 1200 kVA—can they be a third source of power and emergency power within the present requirements concerning safety shutdown devices, (c) the deliberate cold bending of the shafting at alignment—does it in fact straighten when the system is hot at full load and draught, etc.

Finally, the content is intended to be more of a practical than theoretical nature. Directed at the newcomer to this field of tanker newbuilding with very little interest to the marine industry in general as so many other papers can be. The thread of steel intended to run through and bind the continuity of the paper as a whole, being the requirements of the First Entry Report.

3. Historical Development of Tanker Machinery

The s.s. *Gluckauf* was the first ship built to carry oil in bulk. She was commissioned in 1886 and the carrying capacity was 2300 tons. The motive power consisted of a 200 bhp triple expansion steam engine which gave her a speed of about 10 knots and the steam was supplied by two Scotch boilers having a working pressure of 10,6 kp/cm^2. The machinery was already at that time placed right aft for safety reasons and also the cargo pumping arrangement using one pump for several tanks was introduced.

The demand for oil in 1886 was comparatively small, but the trade increased and so did the number of tankers and in 1909 the first separate Rules for the construction of vessels intended for the carriage of petroleum in bulk were issued by the Society.

All the tankers were driven by reciprocating steam engines until 1910 when the first ocean-going motor tanker the 1210 tons dw *Vulcanus* was commissioned. The main engine of this ship developed 490 bhp at 168 rpm and the mean speed of the ship was 8 knots. Many shipowners soon realized the much better fuel economy of the motorship as compared with the steam engine driven ship and by 1920 about 3 per cent of the world tonnage including a number of tankers powered to 3000 bhp were fitted with heavy oil engines. Between 1930–1939 tankers of a capacity of 20 000 tons dw, driven by diesel engines developing about 8000 bhp which gave the ship a speed of 13–14 knots and having steam driven auxiliary machinery were quite common. Low speed two-stroke engines burning residual fuel are now built in sizes of up to 50 000 bhp and nearly 65 per cent of the world tonnage is powered by heavy oil engines. However, nearly all tankers over 200 000 tons dw capacity are being powered by steam turbines.

(a) Steam Tubines

The steam turbine came into the maritime picture in 1897 when the small experimental ship *Turbinia,* fitted with three Parsons turbines and having 2100 bhp, upset a naval review held at Spithead by making a new speed record for ships of 34·5 knots. Parsons' first successful steam turbine came into being in 1884 and from 1890 to 1900 other types of steam turbines were being designed by C. G. P. de Laval, in Sweden, C. G. Curtis, in America, and C. E. A. Rateau, in France. The Parsons turbines were of the all-reaction type. This type was later on improved by fitting an impulse wheel on the first stage in the H.P. turbine thereby reducing the length of the turbine. In the 1920's followed the triple cylinder turbine arrangement with an impulse reaction H.P. turbine and all-reaction I.P. and L.P. turbines. Astern power which should be at least 70 per cent of the full ahead power was provided by an impulse design astern turbine incorporated in the I.P. and L.P. turbine casings. In the 1950's the cross compound arrangement became the standard for a number of tankers with H.P. turbine of the all-impulse type and the L.P. turbine of the all-reaction type. Steam conditions had changed from about 20 kp/cm^2–340°C in 1920 to about 40 kp/cm^2–450°C in the early 1960's, after which these values were raised above 80 kp/cm^2–510°C. The resultant improved fuel economy nearly made the turbine installations competitive with the

large slow-speed diesel engine plants. Reheat turbines are available from all the leading turbine manufacturers, but the favoured installation at present seems to be the cross-compound geared turbine of the single plane design with epicyclic primary gears.

(b) **Gearing**

In the first turbine applications the turbines were directly coupled to the shafts, but in 1910 a mechanical single reduction gear was introduced by Parsons and in 1917 the double reduction gear was used for the first time. The much better results obtained with the geared steam turbine installations made it evident that it would be better to disregard the direct coupled turbine and in the early 20's a number of turbine ships powered from 500 to 2000 bhp were fitted with ordinary single- or double-reduction gearing arrangements. The first gears were not very accurately made. They did not work smoothly and they were noisy and quite often suffered heavy wear. Much work was done, however, on improving the gear-cutting machines and after 1945 the service performance of the ordinary gears has been reasonably good. About 1960 the planetary epicyclic gear was adapted for marine use and a number of large tankers are now fitted with this type of gear in the first reduction, while the second reduction is still of the conventional parallel shaft gear type.

(c) **Boilers**

The *Turbinia* was fitted with a double-ended Yarrow water tube boiler which had a working pressure of 15 kp/cm^2. The cylindrical tank or Scotch boiler which was the standard type being used about 1900 was considered to be too heavy for the purpose. Quick raising of steam, higher pressures and decreased weights are some of the advantages offered by the water tube boiler. Not unexpectedly this type of boiler was first built for warships in 1879 by Belleville in France. Other early designers of water tube boilers are Thornycroft (1885), Yarrow (1889) and Babcock & Wilcox (1889). The Scotch boiler was still very popular for main propulsion of tankers in the 20's and for auxiliary purposes in motor tankers in the 30's, but more and more the water tube boiler came into the picture. An early appreciation of this step in the evolution was made by the Society when, in 1922, rules were issued for the construction of water tube boilers.

(d) **Systems**

With the introduction of the water tube boiler also came the demand for more sophisticated feed water systems. The well-known open feed system, with a wet air pump and two feed pumps of the reciprocating type used on board the conventional steam engine plants was no longer good enough and in the decade from 1920 to 1930 the closed feed system was being developed. This type of system can be rather complicated and although only one independently driven feed pump is required by the Rules it is quite common in modern tanker installations to have three independently driven turbine feed pumps.

(e) **Gas Turbine**

The first gas turbine plant to be used at sea was fitted in the 8269 g.r.t. tanker *Auris* built 1948 and owned by Shell Tankers Ltd. Originally the machinery comprised four 1120 bhp diesel engines each driving an a.c. generator which supplied a 3800 bhp synchronous motor driving the screwshaft at 120 rpm. In 1951 one of the diesel alternator sets was replaced by a 1200 bhp gas turbine driven alternator. This proved to be a success and was much more reliable than the remaining three diesel alternator sets. It was therefore decided in 1956 to remove all the alternators and install a 5370 bhp gas turbine plant which gave the ship a speed of 14·3 knots. The installation was completed in 1959 and the Author had an opportunity to view at this time. Since then gas turbines have been developed for the propulsion of ships of nearly all sizes and in some modern tankers they have also been used as prime movers for emergency or stand-by generators.

(f) **Automation**

Since 1961 a number of tankers have been fitted with a considerable amount of automation equipment and unattended machinery spaces are now quite common. Only a few years ago nobody would have expected such rapid progress concerning automation, but now some degree of central, engine room control, is on nearly every ship being built. Automated boiler installations and generating plants and control of the main engine from the bridge are found increasingly in use and it appears that, as a result of the extensive use of automatic controls mean, the reliability and safety of the machinery installations have been improved.

4. First Entry Report: Machinery Requirements

The spark that lights the fire is the Request 1 (shown in Fig. 4.1). On receipt of this, with Builder's stamp and signature affixed below the information and requirements, so begins the highway of paperwork leading to the propelled steel box designated V.L.C.C.

Those commanding words of the Rq. 1 which include the Surveyors at the newbuilding yard are "that the above vessel may be specially surveyed by Lloyd's Register of Shipping while building". The finger pointing at the engineers in particular being those class notations LMC ✠UMS and part of the Safety Equipment Survey.

The quantity and complexity of the Reports required for each section of the newbuilding machinery are such, that for clarity of objective and eventual peace of mind, it is suggested an aide memoir is compiled as shown in Fig. 4.2 and this is adhered to throughout the progress of construction.

As reports and necessary certificates flow into the newbuilding port or shipyard from colleagues around the world, they can be checked off against the list. The contents of these reports can be verified against machinery installed. This information in turn is included in the respective First Entry Reports (CONST) and so enables an assessment to be made by the Committee towards Classification of the ship.

One may be tempted at first sight to think that many items might have been dispensed with, both on the report forms and lists that follow. However, it will be realised as one examines the structure, that each item included is part of the jigsaw that, when completed, gives a compact word picture of the vessel and its machinery. The first page of the F.E. Rpt. 4 reproduced (Fig. 4.3) is an excellent example of compactness of layout whilst one already begins to see the broad outline of the main items.

The final certificates that are the culmination of effort involved concerning machinery are the Interim Certificate of Class (Figs. 4.4 and 4.5). These are issued on completion of successful sea trials and prior to issuance of the Full Term Certificates from London.

The main object under discussion throughout the paper is, of course, a V.L.C.C. steam turbine propelled. The photographs one normally sees of a tanker as depicted in the glossy

Request 1

LLOYD'S REGISTER OF SHIPPING

Note: Please send this form in duplicate to your local L.R. office

To be completed by local L.R. Office

Port . . . .

No. . . . .

Date . . . .

Builder and Yard No. . . . . Shipyard Ltd.

Owner The . . . . Steamship Co. Ltd.

Proposed Flag . . . .

Length (B.P.) 500 m

Type of Ship Oil Tanker

Breadth (Mld.) 95 m

Depth (Mld.) 50 m

Gross Tonnage (Approx.) 150 000 tons

Type of Engine Turbines

Manufacturers of Engines

Manufacturers of Boilers

Class and Notations Required (Hull, Machinery, Refrigeration) ✠100 A 1. Oil Tanker pt. HT: ✠LMC. ✠U.M.S.

We request that the above vessel may be Specially Surveyed by Lloyd's Register of Shipping while building and agree to pay the established Special Survey Fee or any variation therefrom which has been duly notified and, in addition, any travelling and other expenses which may be incurred by the Surveyors in connection with the Survey.

We also engage to pay any additional fees which may be charged for the issue of any of the certificates indicated below.

This request is made upon the terms of the Rules and Regulations of Lloyd's Register of Shipping which provide that:

"The Committees of the Society use their best endeavours to ensure that the functions of the Society are properly executed, but it is to be understood that neither the Society nor any Member of any of its Committees nor any of its Officers, Servants or Surveyors is under any circumstances whatever to be held responsible or liable for any inaccuracy in any report or certificate issued by the Society or its Surveyors, or in any entry in the Register Book or other publication of the Society, or for any act or omission, default or negligence of any of its Committees or any Member thereof, or of the Surveyors, or other Officers, Servants or Agents of the Society."

In addition we request that the certificates indicated below be issued by Lloyd's Register of Shipping. (Please mark appropriate boxes.)

	Load Line	x	Safety Construction	x
Tonnage	National	x	Safety Equipment	x
	Suez Canal	x	Passenger Safety	
	Panama Canal		Radiotelegraphy	x
	Cargo Gear	x	Radiotelephony	x

Builder's Stamp and Signature ....

Note—To avoid misunderstanding, orders for materials requiring to be tested should be marked as follows:—
"Inspection and Testing by Lloyd's Register Surveyors to the Society's requirements."

Fig. 4.1

YARD No........................

Aide-Mémoire

FIRST ENTRY ENCLOSURES LISTED THUS:

1	Machinery interim certificate of class	
2	Unmanned machinery space interim	
3	Installation of machinery	Part 1 Sheet 1
4	Installation of machinery	Part 1 Sheet 2
5	Installation of machinery	Part 2 Sheet 3
6	Installation of machinery	Part 2 Sheet 4
7	Installation of machinery	Part 2 Sheet 5c
8	Installation of machinery continuation Sheet 4b (Cons)	
9	Installation of watertube boiler—main	5c (Inst)
10	Installation of watertube boiler—aux.	5c (Inst)
11	Installation of st/st generator	5 SGE (Inst)
12	Control equipment	UMS Gen.
13	Electrical equipment	Rpt. 13 Sheet 1
14	Electrical equipment	Rpt. 13 Sheet 2
15	Main steam turbines	Rpt. 4a (Cons)
16	Main engine reduction gearing	Rpt. 4E Sheet 1
17	Main engine reduction gearing	Rpt. 4ee Sheet 2
18	Main engine reduction gearing—epicyclic	Rpt. 4e Sheet 1
19	Main engine reduction gearing—epicyclic	Rpt. 4e Sheet 2
20	Advice of certificates for M.E. F.E.	Port Rpt. 100075
21	Aux. internal combustion reciprocating eng.	Rpt. 4c (ICR)
22	Cert. of running test for alternator as per	Rpt. 4c (ICR)
23	Aux. steam turbines—alternator	Rpt. 4c (ST)
24	Test bed certificate for Rpt. 4c (ST)	Port Rpt. No.
25	Aux. gas turbines—Kongsberg emerg. alt.	Rpt. 4c (GT)
26	Aux. steam turbines for cargo oil pumps (4)	Rpt. 4c (ST)
27	Aux. steam turbines for ballast pump (1)	Rpt. 4c (ST)
28	Report on water tube boiler—main	Rpt. 5c (Cons)
29	Report on watertube boiler—aux.	Rpt. 5c (Cons)
30	Certs. for st/st generator construction	Port No.
31	Certs. for st/st generator construction	Port No.
32	Certs. for st/st generator construction	Port No.
33	Advice of certs. sent to London—March. I & II	
34	Advice of certs. sent to London—Electrical over 100 hp or 100 kW	
35	Electrical motor test sheets under 100 hp	
36	List of shipside valves (concerning Circular 2257)	
37	Pumping schedule	
38	Table of automatic control function UMS	
39	Computer handling list Sheet 1–5 (Circular 2246)	
40	As fitted plans	
41	Machinery lay-out sheets	
42	Certificate of propeller	Port Cert. No.
43	Certificate of spare prop.	Port Cert. No.
44	Certificate of screwshaft	Port Cert. No.
45	Certificate of spare screwshaft	Port Cert. No.
46	Certificate intermediate shaft	Port Cert. No.
47	Certificate thrust bearing	Port Cert. No.
48	Certificate thrust shaft	Port Cert. No.
49	Certificates of important items not tested by the Society's Surveyors, but accepted for installation	
50	Certifying Authorities' Certificates relating to intrinsically safe electrical equipment	

NOTE 1.—Items 42 to 50 are required by Circular 2283–2276 and F.E. statements.

NOTE 2.—If UMS is for a Swedish ship take note of Circular 2240.

NOTE 3.—Special features on F.E. (Inst.) Sheet 3. See Circular 2235.

FIG. 4.2

Rpt. 4a/4b/4f (Inst)
Part 1 Sheet 1
Received London

Report on INSTALLATION OF MACHINERY

FOR CONSIDERATION BY THE COMMITTEE OF LLOYD'S REGISTER OF SHIPPING

NOTE:—The particulars in this report are to be given as fully and as clearly as possible. Where the answer is "NO" or "NONE", say so. Ticks and other signs of doubtful meaning are not to be used. Wording not applicable to be cancelled.

Ship's name	— — — — — —	LR No.	— — — — —
Port	— —	Rpt. No. 1	Date of completing Report: 1973
Number of visits: In shops	40	First date: JULY 73	Last date: SEPT 73
On ship	50	First date: AUG 73	Last date: SEPT 73
Ship built by	— — — — — —	Yard No.	100
Main engines made by	— — — — — —	Eng. No. 1	Year 72, Month 10
Gearing made by	— — — — — —	Gear No. 1	Year ", Month "
Main boiler(s) made by	L.M.	Boiler Nos. 1	Year ", Month "
Aux./~~domestic~~ boilers made by	— — — — — —	Boiler Nos. 1	Year ", Month "
Fee		Expenses	

Particulars of service of ship if limited for classification	OIL TANKER		
Particulars of veg. oil or other special notation, including UMS if required	U.M.S.		
If ship is to be classed for navigation in ice, state whether Class 1*, 1, 2 or 3	NO	Has machinery been tried under full working conditions, including manoeuvring, and found satisfactory?	YES
Is ship an oil tanker?	YES	Date and duration of full power sea trials of main machinery	- - - - SEPT 73
Is cargo refrigerating machinery fitted?	NO	Has spare gear required by the Rules been supplied?	YES
Is it intended to be classed?	NO	Give minimum electrical load on which ship can operate at sea	900 KW
Is refrigerated cargo perishable or a L.P.G.	NO	Give additional load required for refrigerated cargo purposes	NIL
If L.P.G. state if reliquefaction plant	NO	Is main engine fitted directly on tank top or on built-up seating	SEATING
Type of refrigerant	NIL	State material of chocks. If chocks of synthetic material give approved name	STEEL
Is refrigerating machinery space isolated from propelling mchy. space?	NIL	Is engine on flexible mountings?	SLIDING FEET
Number of main engines	ONE	Are flame guards or traps for crankcase relief devices safely positioned?	NIL
Number of propellers	ONE		

Brief description of propulsion system: IMPULSE REACTION STEAM TURBINE & GEARING.

In single main W.T. boiler installations state emergency propulsion arrangements: AUX. W.T. BLR OF 50 TONS/HR —— 10 KNOTS

Main Steam Turbines (*to be reported on Rpt. 4a(Cons)*)	Port — — — — —	Rpt. No. — — — — —
~~Main Internal Combustion Reciprocating Engines (*to be reported on Rpt. 4b(Cons)*)~~	Port	Rpt. No.
~~Electric Propulsion (*Electrical Particulars to be reported on Rpt. 4d*)~~	Port	Rpt. No.
Reduction Gearing (*to be reported on Rpt. 4e*)	Port — — — — —	Rpt. No. — — — — —
Main Boilers (*to be reported on Rpts. 5a/b/c*)	Port — — — — —	Rpt. No. — — — — —
Aux./~~Domestic~~ Boilers (*to be reported on Rpts. 5a/b/c*)	Port — — — — —	Rpt. No. — — — — —
Gas Turbines (*to be reported on Rpt. 4f (Cons)*)	Port — — — — —	Rpt. No. — — — — —
STM/STM GEN	" — — — — —	" — — — — —

FIG. 4.3

LLOYD'S REGISTER OF SHIPPING

INTERIM CERTIFICATE OF CLASS

Port ....

Date ....

T.T..............

This is to certify that the machinery of the T.T. ...., 150 000 gross tons of .... has been constructed and installed under the Special Survey of the Society's Surveyors in accordance with approved plans and the Society's Rules, Regulations and Requirements and was found on the above date to be in good working condition.

A report is being forwarded to the Committee of Lloyd's Register of Shipping, London, recommending that the following Class Notation should be made in the Society's Register Book:

✠L.M.C. 2.73			T.S. (OG) 2.73	
One Main W.T.B.	74,2 Kp/cm^2 -		Saturated	
	66,4 Kp/cm^2 -	513^{o}C	Superheated	2-73
One Aux. W.T.B.	68,8 Kp/cm^2 -		Saturated	
	66,4 Kp/cm^2 -	320^{o}C	Superheated	2-73
One St/St Gen.	14,5 Kp/cm^2 -			2-73

....

Surveyors to Lloyd's Register

This Certificate is issued upon the terms of the Rules and Regulations of the Society, which provide that:—

"The Committees of the Society use their best endeavours to ensure that the functions of the Society are properly executed, but it is to be understood that neither the Society nor any Member of any of its Committees nor any of its Officers, Servants or Surveyors is under any circumstances whatever to be held responsible or liable for any inaccuracy in any report or certificate issued by the Society or its Surveyors, or in any entry in the Register Book or other publication of the Society, or for any act or omission, default or negligence of any of its Committees or any Member thereof, or of the Surveyors, or other Officers, Servants or Agents of the Society."

N. Cert. B (FE) 30m,2,67 (MADE AND PRINTED IN ENGLAND)

FIG. 4.4

LLOYD'S REGISTER OF SHIPPING

INTERIM CERTIFICATE OF CLASS

Port ....

Date ....

T.T. ....

This is to certify that at the request of ---------- Steelshipyard, the undersigned Surveyors to this Society have surveyed the:-

Control Engineering Equipment

Of the T.T. .... 150 000 gross tons of .... on the 1st January 1973 and subsequently found it in accordance with the relevant Rules of this Society for operation with unattended machinery spaces and in good working condition.

We are reporting accordingly and recommending to the Committee of Lloyd's Register of Shipping that the Notation U.M.S. 2.73 be made in the Register Book in respect of the automated machinery of this vessel.

Surveyors to Lloyd's Register of Shipping

N. Cert. B (FE) 30m,2,67 (MADE AND PRINTED IN ENGLAND)

Fig. 4.5

journals are superb aerial views of an immaculately painted ship speeding through an advertising agency sea. The inevitable white bone of speed at the bow depicts the contained herculean thrust and power. This depiction through the eyes of the newbuilding Surveyor is more often than not the forlorn object shown in Plate 4.1 "Newbuilding or Breakers Yard".

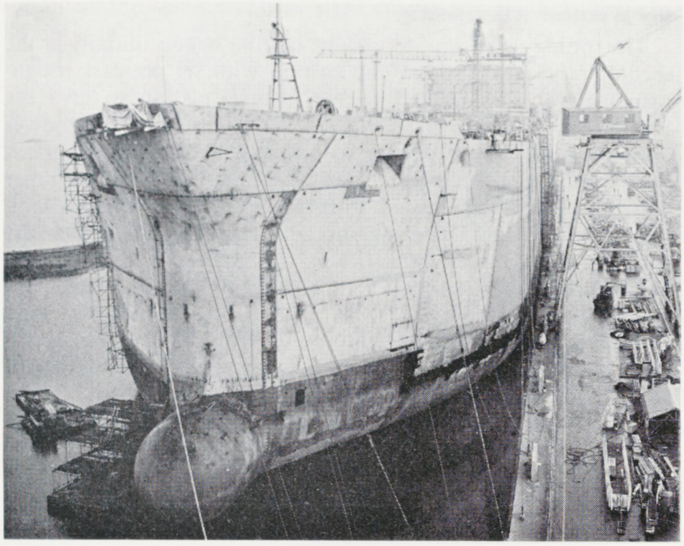


PLATE 4.1

5. The Model of the Machinery Space and Its Usage

The present practice at the Odense yard is to include, in the purchasing price of the ship, the rather high cost of making an engineroom model. This model is constructed approximately one year prior to the actual building and is primarily for the benefit of the pipe assembly people as it allows everybody to see the problems three dimensionally. However, Owners' Superintendents have a wonderful opportunity to alter items to their satisfaction at a greatly reduced cost and inconvenience than if they were on board the ship with real machinery.

Plate 5.1 shows a portside forward section of an engine room with condenser, L.P. turbine and half of the gearcase all on their respective seatings. The steam to steam generator can be seen two decks higher. The model size of the components can be roughly gauged by comparison to the chair in the background.

For the Surveyor the model is a boon in many ways. The accessibility of bilge strum boxes and valves can be ascertained.

Before the days of model building many brackets or stiffening members were broached. When one crawled around the under deckhead staging checking lines and valves, a lookout had to be kept for such instances and compensations recommended as necessary. This has now been obviated because pipe run obstructions can be seen earlier.

As pipelines and valves were being fitted, those valves under the deckhead had a tendency to be mounted by mistake, with actuating spindles facing downwards. The burner squad came around later to cut access holes and make covers in the deck platform plating above the valve. However, when they saw the spindles facing downwards these valves were left alone. At a later date the staging was finally removed and one then had a valve high up under the deckhead making operation difficult. All this has been eliminated due to the ability to see everything on the model. When completed the model is fully assembled and placed in a building at the fitting-out dock and is now an indispensable aid to the various participating trades. All this speeds up production and obviates repetitive mistakes.

Plates 5.1 and 5.2 show the aft end and boiler location. With regard to classification there are further advantages of being able to give decisions at a very early stage and so be regarded more as a help than hindrance. The pipelines are in their designated traditional colour codes and easy to follow. As such, the location of electric cable trays away from oil fuel line flanges, units and steam pipes can be suggested, to comply with rule requirements, Instructions to Surveyors, etc. The oil fuel burner rail system can have joints or flanges arranged to be in view and accessible. Details for the Safety Equipment Certificate can be dealt with. Fire main nozzles and length of hose accessibility gauged, engine room air ventilation trunking outlets placed away from detector heads (Ref. 1). Location of fire appliances relative to the approved fireplan can be assessed. With a top-fired boiler, appliances can sometimes be far away from the area likely to cause danger, the realisation that it is top fired not being apparent from the plan. Having access to such a model for a Surveyor is, as one can imagine, a great advantage.

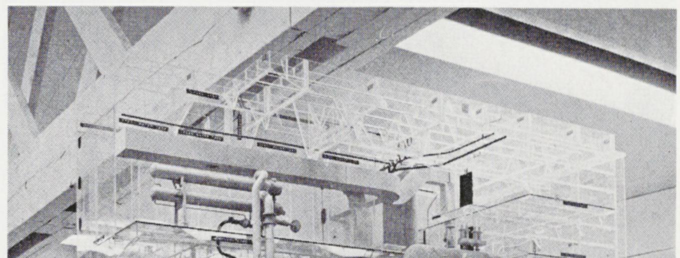


PLATE 5.1

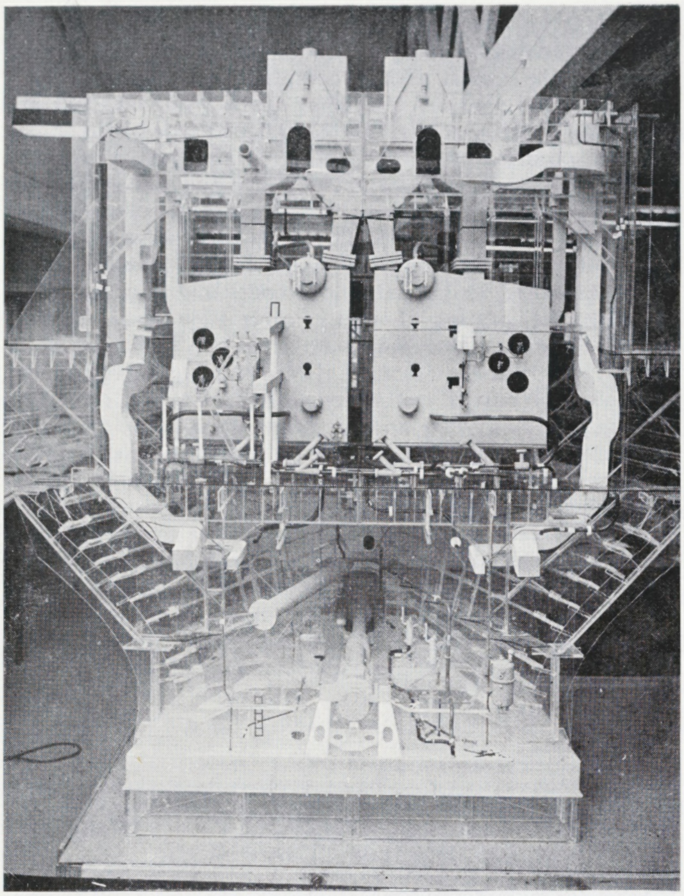


PLATE 5.2

Concerning the First Entry Report. Many items can be filled in concerning location of machinery and the report work thereby advanced. The actual fitting on board of the machinery is then a double check and so newbuildings sail away with very few items unanswered through being forgotten from pressure of work.

The success of this model preview project is such that certain large companies that keep to the same automation equipment are thinking of setting up a simulation console of full automation layout. They will then feed in disasters, so giving their engineering staffs practice in fault rectification and general acclimatisation under simulated conditions. Underwriters will undoubtedly appreciate this.

The largest disadvantage to a Surveyor making recommendations at the model stage is that when production starts it is difficult to change anything on board. Luckily very few cases have arisen. However, at Odense there are only two Ship and Engineer Surveyors, being my colleague and myself. When we are invited to attend the "Official Viewing" which is final before production starts, together with Yard Management and Owner's Representatives, a certain amount of trepidation assails us. We each have a printed card in our top pockets and the ritual is to show it to each other before entering the model room. They both give the same warning "Engage brain before opening mouth".

6. Installation of Machinery—Basic

(a) The Boring Out of the Sternframe and its Alignment

Although the description that is to follow is representative of the procedure at a particular shipyard, it may well give an introduction to sternframe alignment otherwise not generally available to Surveyors in other ports.

(i) "Vertical Alignment"

The setting up of the sternframe casting begins initially in the section fabrication shop. The casting with its pre-cast rough-machined boss is welded to pre-formed plating to give the Section No. 1 as shown in Fig. 6.1. This is the complete lower after-peak section. It can be seen that the inboard rough-cast sternbush housing has also been welded in place. These inner and outer bores are sealed with a steel hoop to form a continuous watertight tube against ingress of water from the surrounding aft peak tank. Later the inner and outer white-metalled sternbushes will be hydraulically pressed into this space (described later).

Section No. 1 has three holding lugs welded to its exterior, into which the crane wire ropes can be shackled for manœuvring in the planes forward and aft, port to starboard, or lifting and lowering during the alignment period. The outer bore of the sternframe casting has been cast and then rough-machined at an angle of 1:61 at the foundry. The inner bush has also been incorporated in this section at the pre-fabrication shop in this incline of 16,4 mm per metre length corresponding to the rise of 1:61. This is part of the shaft alignment requirements. (See section on Shaft Alignment.)

(ii) Reference Line

On the dock bottom are two brass inserts with deep centre punch marks in their centres. The optical instrument is first set up over the aftermost mark. This point is in the exact centre of the instrument tripod and the ship's centre line is checked by the prism and spirit level incorporated in the instrument. The forward marking insert which is also the centre line of the keelblock system and the ship's centre line is then sighted. The instrument's circular horizontal-vernier should then read zero, so giving the "Reference Line".

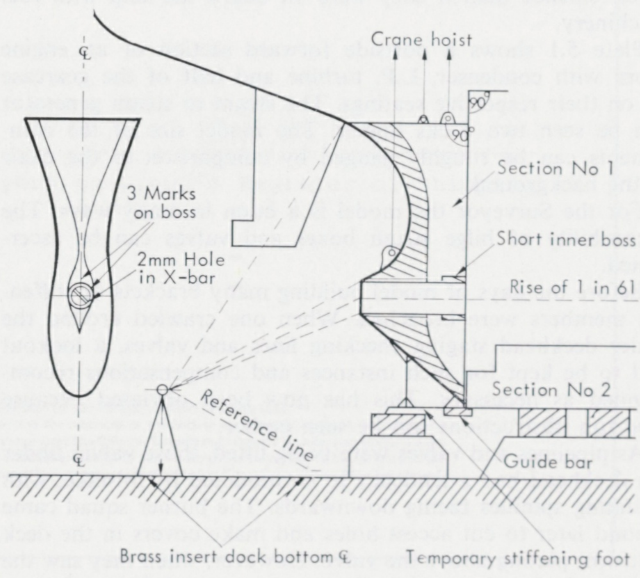


FIG. 6.1

(iii) **Lining Up**

The end and side views in Fig. 6.1 show the boss to have three vertical centre punch marks both on the upper and lower faces of the boss. A flat bar has been welded across the open face of the casting bore and into it is drilled a 2 mm hole. The hole is in the exact centre of the rough-machined bore. A similar centre punch mark is at the uppermost projection of the section. These sight marks are sighted through the optic in the vertical plane, and the crane advised to move to port or starboard or cant section as required. Plate 6.1 shows the general arrangement. The manœuvring continues until the complete section lies in the vertical plane required as in Fig. 6.1.

A base guide bracket has been pre-welded on the engine room Section 2 (side view in the figure), to give the preliminary height of base alignment of both the sections being mated. Also a temporary stiffening foot of "H" section steel has been welded on the extreme aft end of Section No. 1 (barely seen in Plate 6.1) for further support to upper sections of steering gear compartments, boilers, etc., which are added later giving additional top weight.

The side view (Fig. 6.1) shows the completed boss tunnel to have a rise of 1:61. As previously stated this has been initially cast and machined thus, and also part prefabricated forward when the complete section is constructed. However, the deck top is in a true horizontal plane and the mating face in the true vertical plane, the angle as shown being 90°. Any further correction to gain the required inclination can be achieved during later boring out. At this stage the section is in the true vertical plane and central to the ship's centre line (looking forward from aft).

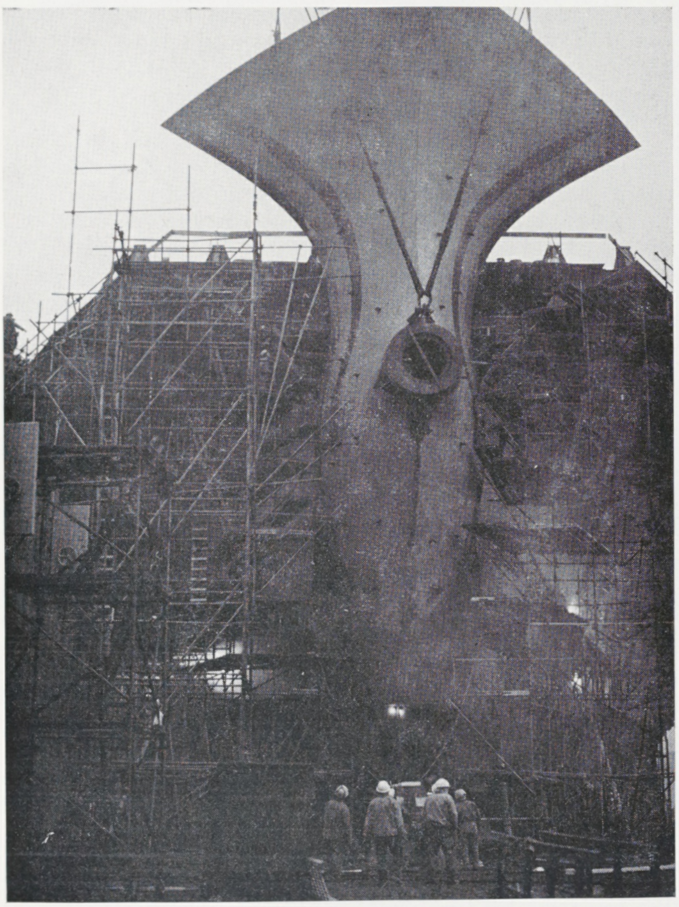


Plate 6.1

Beginning vertical alignment of sternframe and boss.

(iv) **Horizontal Alignment**

This is carried out from within the ship. The pump room and engine room section of 400 tons each are in place and adjusted from the base and reference line at a prior date and need not concern the Engineer Surveyor except possibly from the academic interest of seeing how it is done. The more one understands about the complete article the more time one can spend on detail.

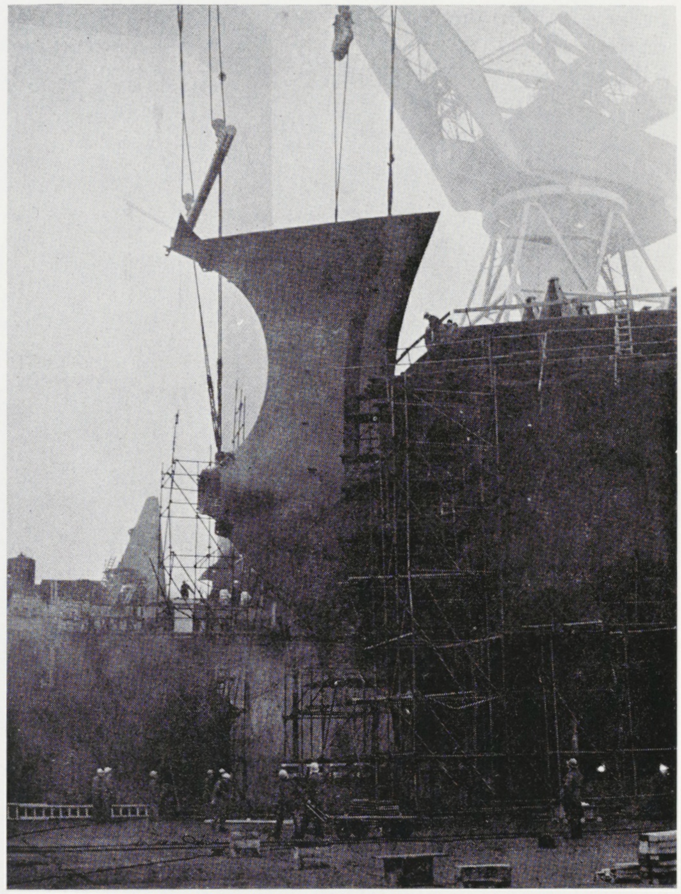


Plate 6.2

The alignment in the horizontal plane with the aft to forward rise of 1:61 is now carried out. If the tolerances in the fabrication halls have been adhered to, the mating faces of sections Fig. Y and Fig. Z as shown in Fig. 6.2 will be perfect and only the height of the centre line need be adjusted. However, slight tilting is required at times and the edges have to be faired in places by flame cutting, although very little has been noted on the last series of vessels at this port.

Fig. 6.2, Detail "A", shows the bar welded across with the 2 mm hole in the centre of the boss. A steel rule is hung by a magnet alongside this.

Fig. 6.2, Detail "B", inboard, a similar steel rule is hung on the centre line of the boss by a magnet.

The engine room section foundation stools for the intermediate shaft bearing, thrust shaft bearing, main gearing, H.P. and L.P. turbines, condenser, have already been inserted and welded up. These foundations are all set at a specified height from the base line and tank top with their bases cut at the angle 1:61 and this alignment being carried out in the halls during fabrication. At this stage, with the aft end in place, a height "x" has been marked on the engine room bulkhead forward and at its centre line to give rise between point position "A" to position "E" of 1:61 as required. The instrument "C" is set up to have position "E" in the flat plane (Fig. 6.2). However, the condenser and forward machinery is installed as quickly as possible with the gearing and turbines, so losing point "E". Therefore an intermediate point "D" is arranged within this line. The optic is then set to this intermediate point and all future reference lines emanate from here.

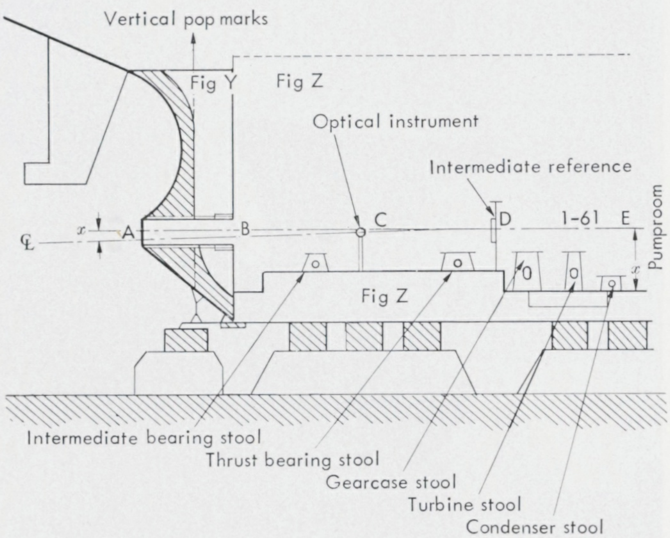
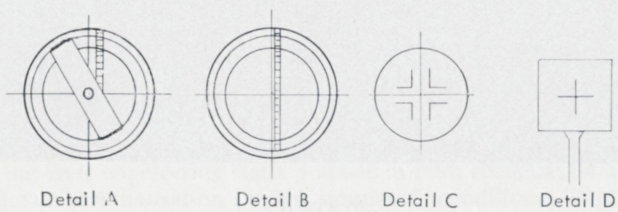


FIG. 6.2



Detail of FIG. 6.2

Although the instrument is offset from the centre line of viewing (Fig. 6.3) it should be remembered that this is only for the alignment in the horizontal plane and for the height above baseline. In Fig. 6.2 it will be seen that the reference mark at position "D" is slightly higher than that required at position "A" due to the incline. The instrument has been set in this plane and only swivels but does not tilt. The section is then lowered until this distance "x" appears on the rule placed at position "A" above the centre line required. The height at position "B" will obviously be slightly less and is obtained from a prior calculation using the length of sterntube recess from "A" to "B". To gain position "A" the section is lifted or lowered. To gain position "B" the section is tilted backwards or forwards keeping "A" steady as a fulcrum point.

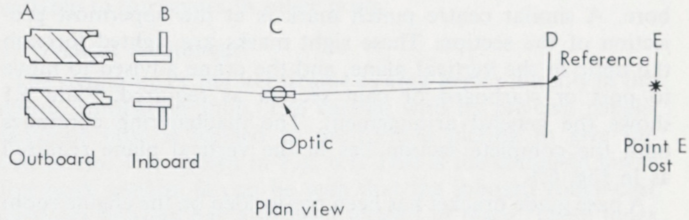


FIG. 6.3

When all the alignment is satisfactory the complete section is tack welded to the engine room section that is already in place. The section at this stage is in the correct horizontal plane. As upper sections and machinery units are added these alignments are checked until such time as the aft end is all welded and in place.

In previous instances the centre line A–B was set 10 mm high to allow for crushing of the blocks. However, a new construction of block and the use of hardwood wedges, has failed to show any appreciable drop. Small differences can be taken up when machining. A final check against a vertical line of centre punch marks on the casting side can be taken from the dock.

Of Particular Interest to the Surveyors

The welding of the thin plate relative to the mass of casting can give problems even though the material has been preheated before welding takes place. It is as well to crack detect the welds with dye penetrant as shown in Fig. 6.4. The weld at the aft peak to engine room bulkhead has instances of cracking. This should be chipped out and re-welded.

Examine any oil inlet or outlet gutters that are present and grind smooth as thought necessary.

(v) **Setting up the Tool for Machining**

Fig. 6.4 shows the sternframe casting and inner part. Line A–B (aft) shows four "L" brackets welded on the casting with adjusting screws threaded through the brackets, and likewise at C–D (forward). These are used to set the centre of the bore physically with a micrometer and in conjunction with optic (Plate 6.4) to see if the centre of the rough casting inner bush is true in the required slope. The boring machine can be set up to these centres. If a slight difference in angle is required to come in line with the overall alignment in Fig. 6.2, then the tool can be set to take an angled run of cut. A 5 mm offset is a guide to the maximum suggested, dependent, of course, on the material thickness. After the traditional type boring tool is set up in the centre of the four points aft and forward as required, then cutting can begin.

Prior to the last few cuts the machine is removed and the boring tested for requirements as explained in 6(a) Horizontal Alignment. The steel foot being removed to allow sag, if any. All being well the final cuts are taken.

The bore is measured internally with a micrometer to suit the fit of the whitemetalled sternbush, and then a final optic alignment is taken. Porosity will be found in certain instances but unless over a large localised area it is not considered too much of a problem.

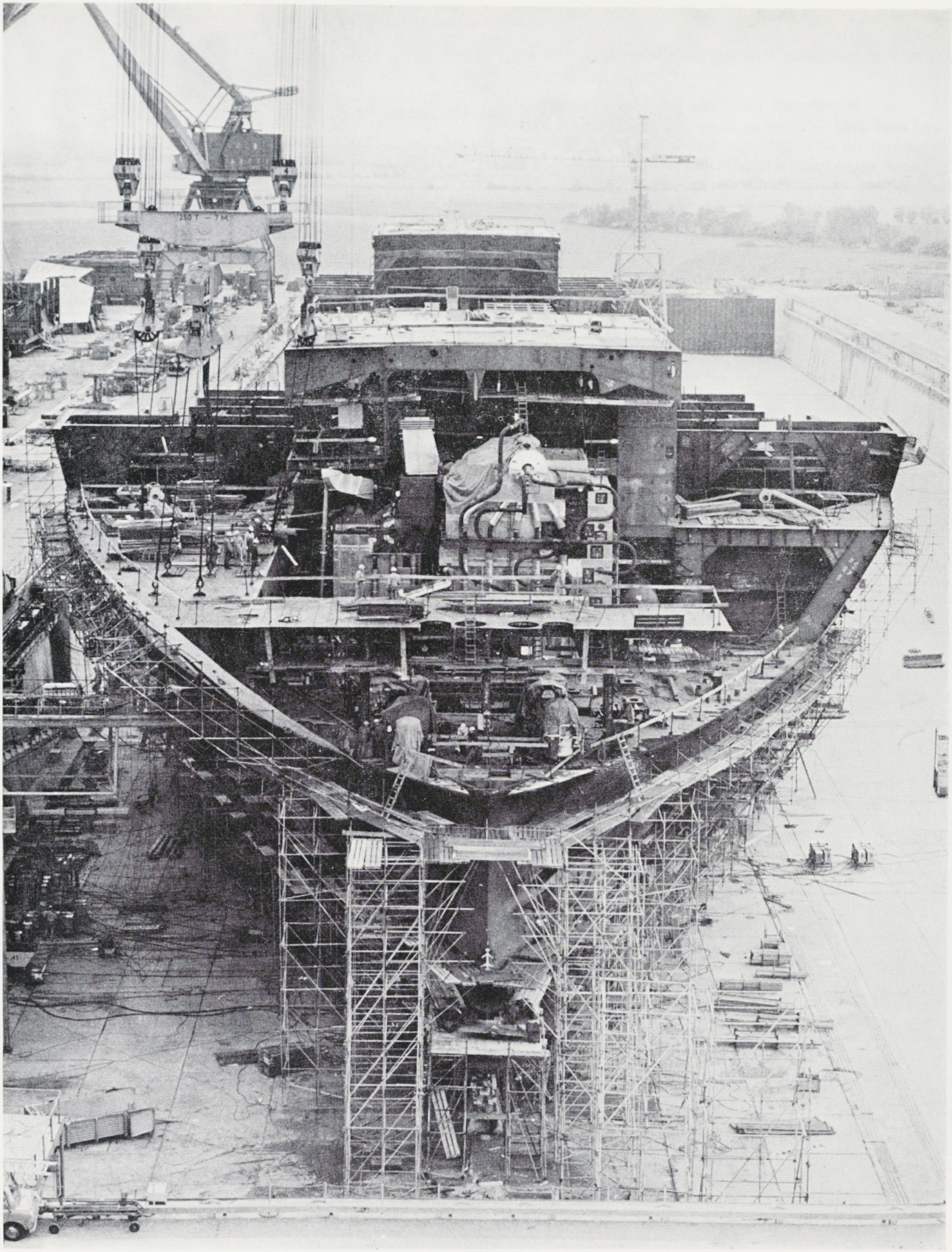


Plate 6.3
Placing of boilers and machinery during sterntube alignment.

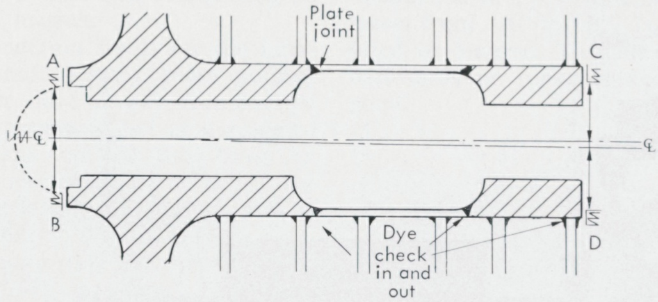


FIG. 6.4

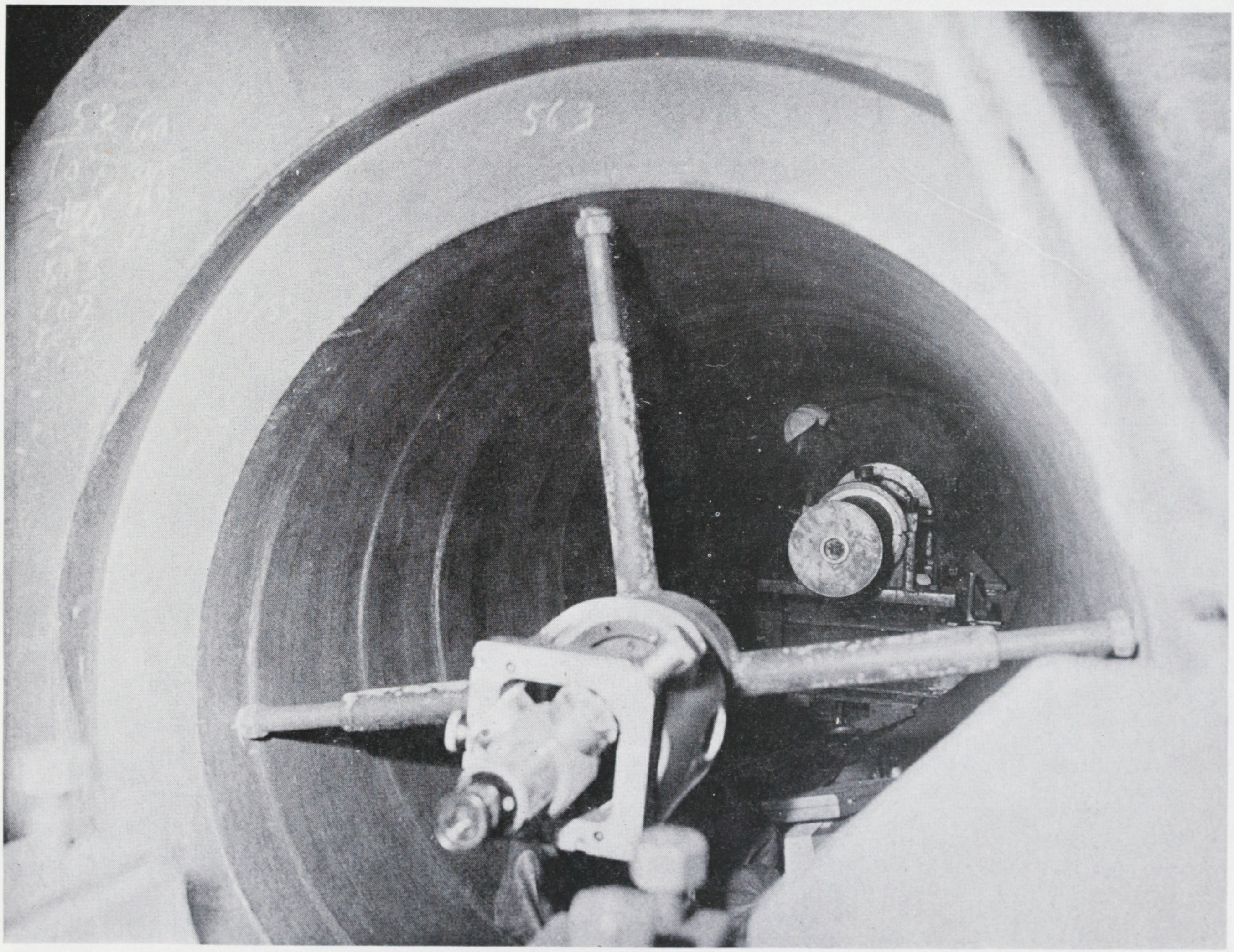


PLATE 6.4

Plates 6.5 and 6.6 show instances of porosity encountered. The measure can give some idea of the diameter of each defect and areas involved.

(vi) **Porosity**

Usually it is spread over the casting as shown in Plates 6.5 and 6.6. However, should it be localised causing a large depression, it may be worth thinking about filling the space with a solid or non-compressible substance to prevent any palpitation of the bush in this area which might affect the bonding of the whitemetal.

Areas as large as 20 per cent of the bearing surface are even considered acceptable in the Author's opinion. Should the porosity be found by ultrasonics at the foundry then it can, of course, be welded up with subsequent heat treatment taking place.

(b) **Fitting of the Inner and Outer Sternbushes**

Fig. 6.5 should be self explanatory. The stern boss has been examined for porosity and accepted. The aftermost bush is entered and a centre line which is marked in its flange is lined up with a centre line on the sternframe casting. A thick pressure plate is hung in way of the bush flange to distribute the load and four jacks placed between the flange and strongback.

Examination of oil gutters or temperature probe channels should be made and these proved clear and free from debris. The hydraulic pressure of the jacks is dependent on the inter-

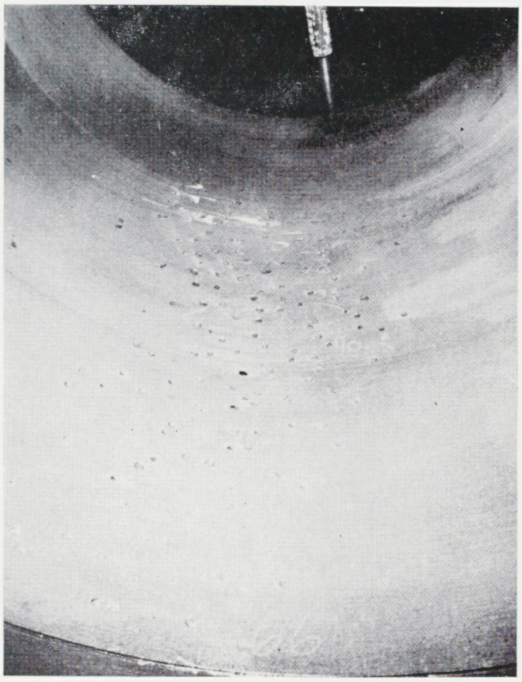


Plate 6.5

Plate 6.6

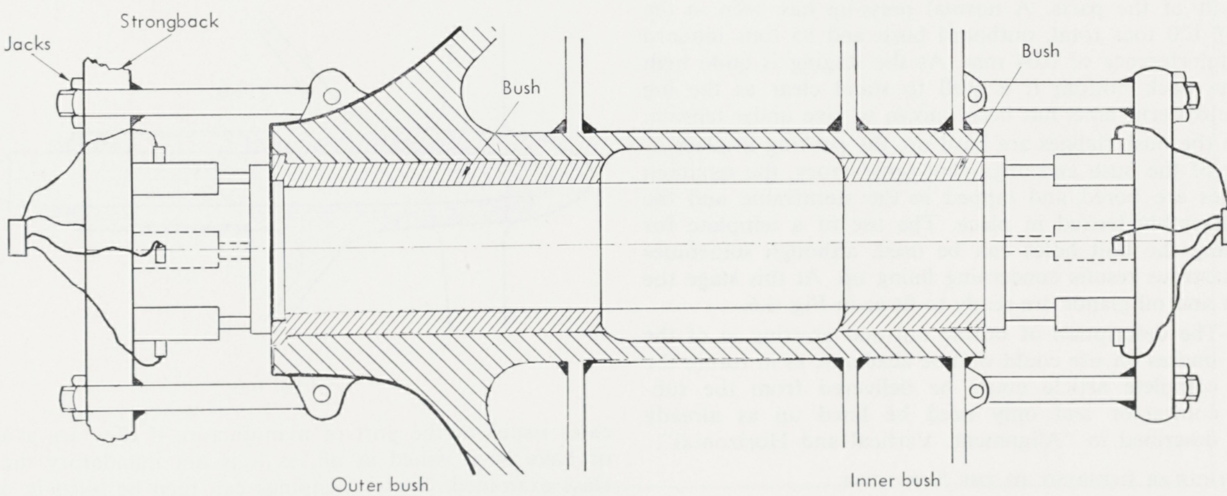


Fig. 6.5

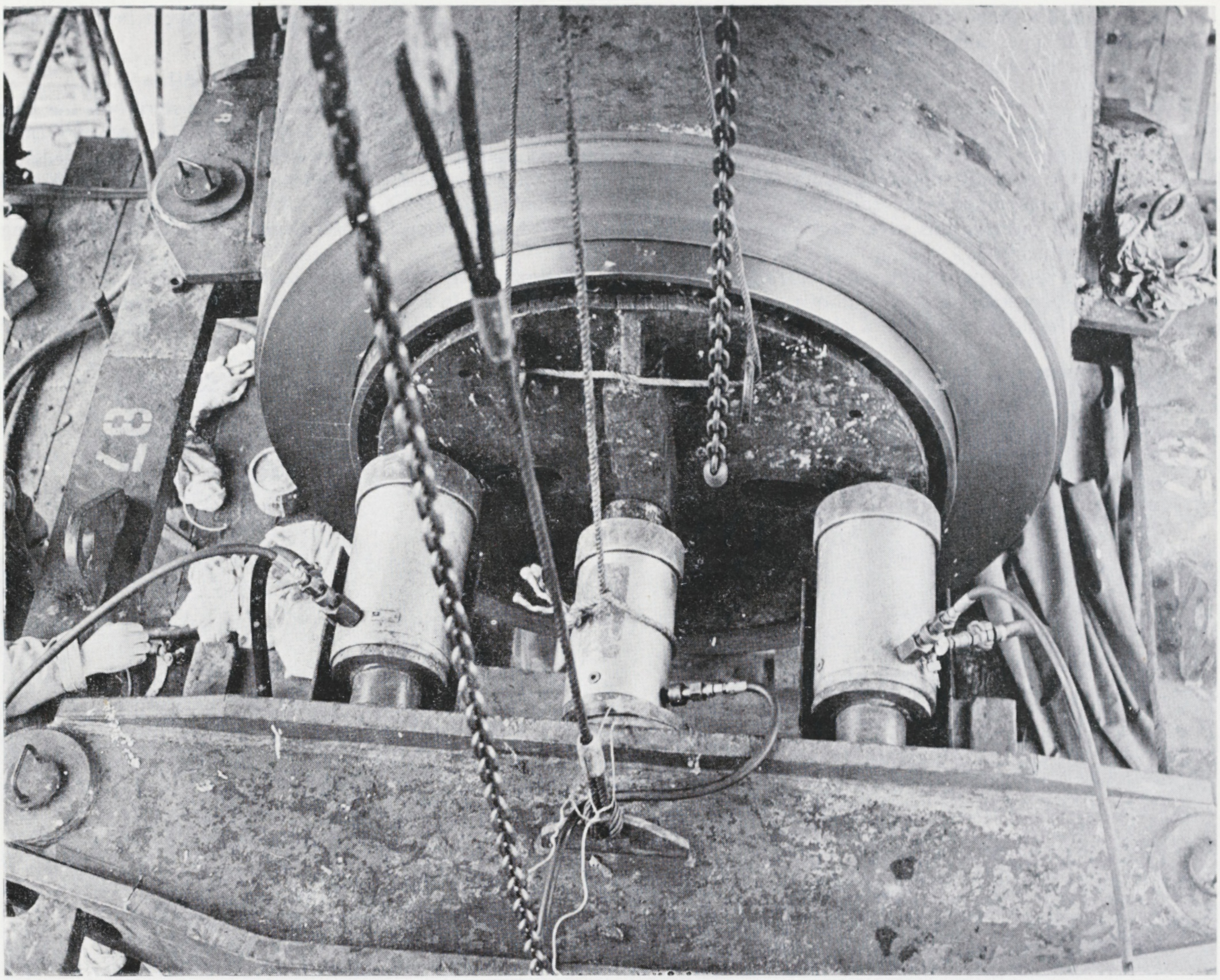


PLATE 6.7

ference fit of the parts. A normal press-up has been in the range of 120 tons total, outboard bush and 85 tons inboard for an interference of 0,04 mm. As the staging is quite high from the dock bottom it is well to stand clear as the lug welding to sternframe, has been known to give under tension.

When the bush flanges are hard up, the packing in place at the rear of the bush and alignment satisfactory, the retaining bolt holes are bored and tapped in the sternframe and the whole assembly locked in place. The use of a template for pre-drilling the bolt holes can be used, although sometimes with disastrous results concerning lining up. At this stage the tailshaft and oil glands are ready to fit as in Fig. 6.6.

NOTE.—The description of boring out and pressing in of the bushes on site could well be academic as in future the complete article could be delivered from the sub-contractor and only need be lined up as already described in "Alignment, Vertical and Horizontal".

OF PARTICULAR INTEREST TO THE SURVEYOR

Before the bushes are entered it is well to take notice of any identification stampings and verify these with the certificates issued at the port of manufacture if they are available or have been issued at all, as it is not mandatory they are class examined. These stampings can then be filled in on the F.E. Rpt. 4b (cons) cont. under Identification Marks of Important Castings.

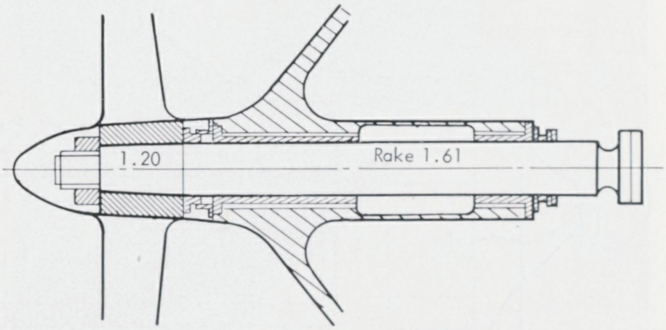


FIG. 6.6

Ship's name LR No. **Rpt. 4b (Cons)** *(Continued)*

DECLARATION TO BE SIGNED BY ENGINE BUILDERS

To the best of our knowledge this machinery has been soundly constructed in conformity with the Rules, Regulations and requirements of Lloyd's Register of Shipping, and the foregoing particulars of main engines are correct.

Signature.. Date..................

IDENTIFICATION MARKS of important forgings and castings. (*Shafting Certificates to be forwarded.*)

Crankshaft

Thrust/~~flywheel~~ shaft

Is a detailed list of certificates attached to the report stating item, manufacturer, port of issue, certificate No., & identification marking?

DATE AND PORT OF APPROVAL OF PLANS. State if general approval.

Crankshaft	Thrust/~~flywheel~~ shaft	Air Receivers

A previous similar case was for (*name*) Eng. No. Port & Rpt. No.

The machinery reported above has been built under Special Survey in accordance with the Rules, approved plans and Secretary's letters, examined running on the test bed and found satisfactory. The materials and workmanship are good, the spare gear required by the Rules has been supplied, and the machinery is eligible in my opinion to be fitted in a classed ship.

....

Surveyor to Lloyd's Register of Shipping

Date of Committee

Minute

FIG. 6.7

(i) a sternbush fitted in a bossing (H 226).

(ii) length of bearing next to and supporting propeller (H 236(a)).

(iii) material of bearing (H 236(b)).

can all be entered at this time.

(c) **Fitting of the Tailshaft**

At this stage the aft and forward thermometer probes are fitted and the associated wiring attached in place (*see* Fig. 6.8). Inlet and outlet oilways should be examined where the stub pipes have been welded internally and any weld blow-through chipped out or ground smooth. These oil stub pipes are usually galvanised internally. Fig. 6.8 shows the arrangement prior to the tailshaft being fitted.

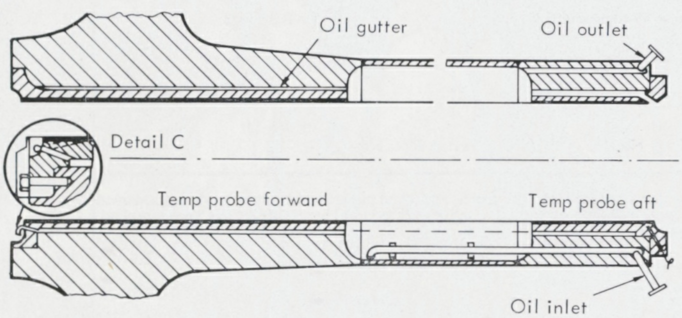


FIG. 6.8

The tailshaft is now ready for entering into place. The complete inboard oil seal gland assembly is slipped over the shaft and pushed along to the coupling flange. Any visible marking for identification purposes being noted. The gland need only be of an approved type and as such a certificate need not be and may not have been issued. Identification stampings can be taken from the tailshaft and verified with its certificate. It is well to take these stampings now as the coupling flange normally has a guarding material around its periphery to avoid damage from the centring jack screws used during alignment It was common practice to position the jacks around the shaft itself. However, during one dock trial the removal clearance was insufficient and one deeply scored the shaft. The tailshaft is now entered into the bush and pushed through. As the cone exits from the aft bush the outer seal is mounted and pushed against the boss. This seal is still in its complete assembly stage and has not been split in any way. The tailshaft is further ejected from the engine room until the distance from the coupling flange face to the aft peak bulkhead is according to a pre-arranged length which will give an external gap between sternbush and propeller boss to the seal manufacturer's requirements (*see* Fig. 6.9).

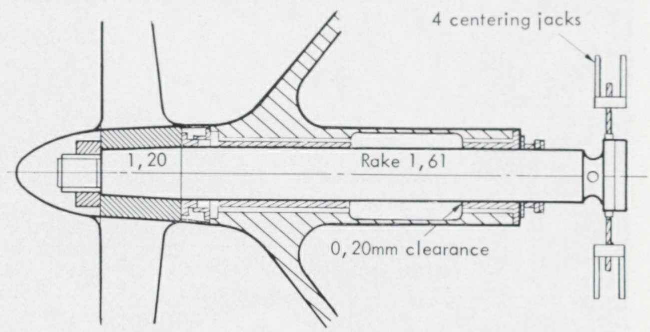


FIG. 6.9

The screw jacks around the tailshaft coupling flange are now brought into contact with the brass protection strips. The shaft is centralised regarding port and starboard emplacement and the gaps each side equalised with feeler gauge readings. The tailshaft, however, is lifted 0,20 mm away from the bottom of the inboard bearing whitemetal at its forward end. This measurement is the beginning of the "Shaft Alignment" requirements to be described later. These four clearance readings should be noted for future reference. The inner seal is still draped around the shaft by the coupling flange. The outer seal is resting against the boss face but not fitted or bolted as yet.

At this stage the description of the fitting of the seals and tailshaft becomes a little involved as the propeller is mounted. This "Propeller Fitting" description will be part of a later section. It is therefore the Author's intention to digress a little by discussing approved glands. Many of us glibly discuss weardown clearances allowable at drydocking, but in many cases are not too conversant with the internals of the gland. Further to this, the internal directive stating that "Ship Surveyors shall examine and report tailshaft weardown and tightness of oil seal system at annual docking and advise their engineer colleagues should it be excessive", makes it thought, therefore, that it might be of interest to a wider field of colleagues both ship and engine, to give a simple sketch and description of the internals and working of a gland such as a Simplex type approved oil gland.

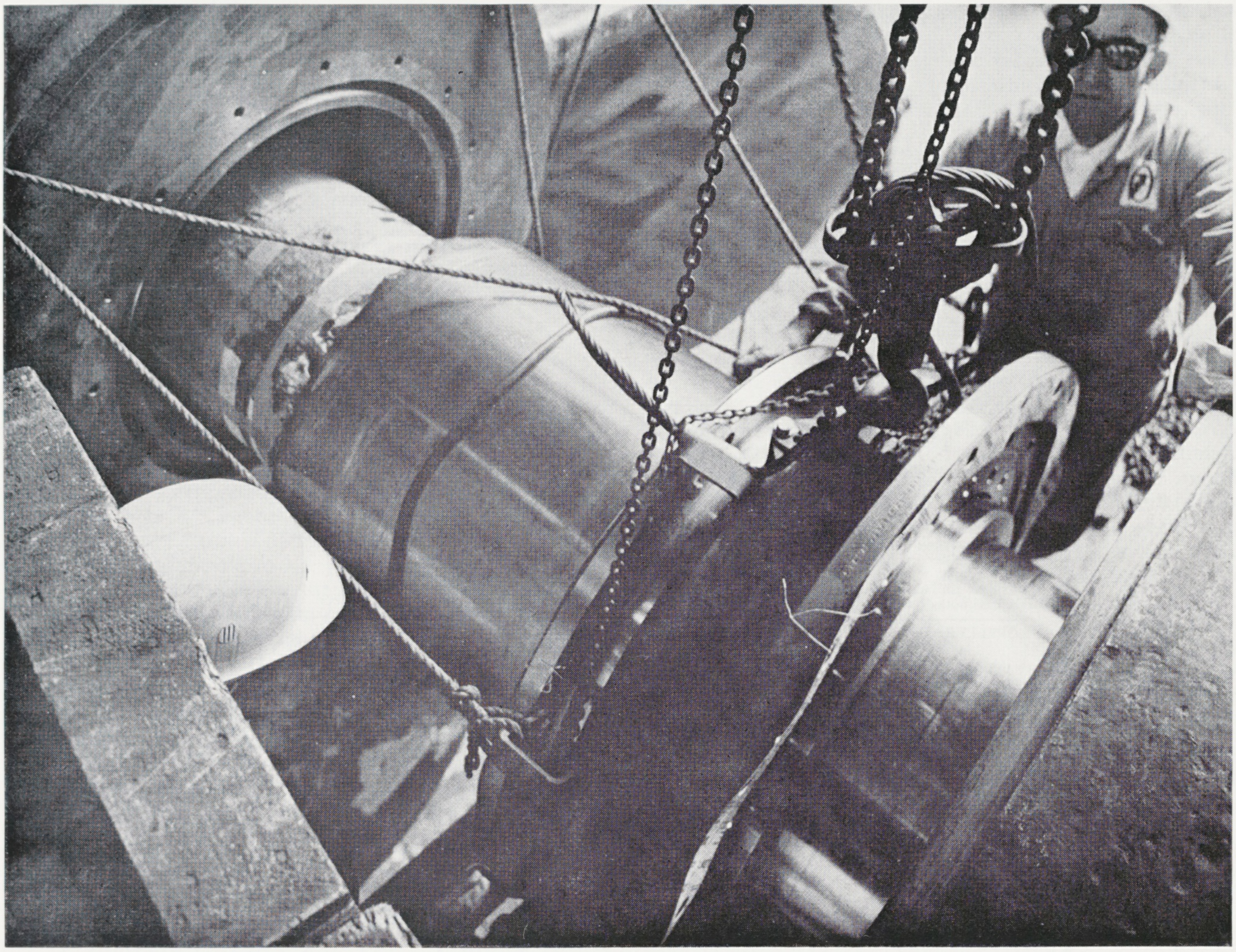


Plate 6.8

Ship's name | Port | Rpt. No.

Date and letter reference of London approval of T.V.C.s
Working propeller
Spare propeller

Particulars of barred speed ranges imposed with
Working propeller
Spare propeller

NOTE.—The particulars in this report are to be given as fully and as clearly as possible. Where the answer is "NO" or "NONE" say so. Ticks and other signs of doubtful meaning are not to be used. Wording not applicable to be cancelled.

STRAIGHT SHAFTING

Max. BHP/SHP approved for each line of shafting | Corresponding propeller RPM | Corresponding engine RPM for geared or elec. dr. installations

Thrust Shaft Shaft diameter adjacent to collar

Material — Approved | Actual

Tensile strength

Intermediate Shaft Diameter — External | Internal

Material — Approved | Actual

Tensile strength

Screwshaft Diameter of propeller cone at large end, or in body if flanged shaft

If hollow state internal diameter

State type of forward coupling (e.g. solid, muff, etc.)

Is screwshaft and/or tubeshaft fitted with continuous liner?

Method of securing liner (shrunk on, epoxy resin, etc.)

Give location of any joints in the continuous liner

Are joints of approved type?

Is a sterntube fitted, or is sternbush fitted in sternframe bossing

If sternbush of special design, give type

Can sternbush bearing be examined without drawing shaft?

Tubeshaft (*if separate*) Diameter

Material of screw/tube shaft — Approved | Actual

Tensile strength

Thickness of screw/tube shaft liner at bearings

Thickness of screw/tube shaft liner between bearings

How is aft end of liner made watertight? — External | Internal

If an approved type oil gland fitted, state name

State method of screwshaft protection if not fitted with continuous liner or oil gland — NOT APPLICABLE

Length of bearing next to and supporting propeller

Material of bearing

Material of sterntube

Give original poker gauge reading where fitted

In multiple-screw ships is liner between sterntube and 'A' bracket continuous?

If not, is exposed shafting between liners readily visilbe in dry dock?

PROPELLER

State design

How is it secured to shaft (flange or cone)

Is propeller keyless type?

If hydraulic nut fitted, state type

If keyless design, state if bore sleeved

If sleeve secured by epoxy resin, give results of test after pouring

If of controllable pitch type, state method of control

	Working	Spare
Port and Cert. No.		
Material or trade name		
Solid, built or controllable pitch (CP)		
Left hand (LH) or right hand (RH)		
Number of blades		
Diameter		
Design moment of inertia, dry		
If ice notation required, state Class		

DECLARATION TO BE SIGNED BY INSTALLING ENGINEERS
To the best of our knowledge this machinery has been installed in conformity with the Rules, Regulations and requirements of Lloyd's Register of Shipping, and the particulars of main and auxiliary machinery and pressure vessels are correct.

Signature.. Date..........................

FIG. 6.10

(d) Fitting of the Inner and Outer Glands

Fig. 6.11 is reasonably self explanatory.

Part "A" is attached to the aft bulkhead arrangement.

Part "B" is attached to the shaft and rotates.

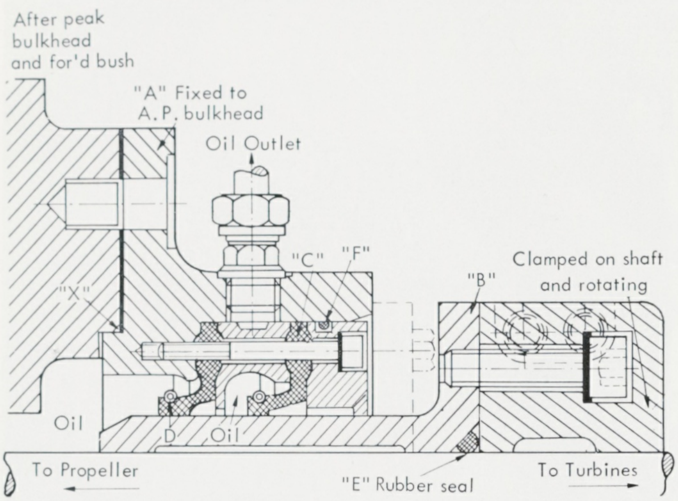


Fig. 6.11

Inboard oil gland seal.

Two seals "C" are clamped in the stator and held against the shaft member initially with pressure from two garter springs "D". The oil pressure in the sterngland space augments the latter. There is a rubber shaft seal at "E" (rotating part) and another at "F" (static part). The alignment or centralizing of the gland is achieved by the pre-machined circumferential shoulder at "x". Oil enters at the lower half of the seal under pressure from a pump, driving out any air and returning to its header tank and cooler through the top outlet. This oil circulates between the two preformed circular synthetic rubber seals. Another system of oil circulates, in the shaft-bush space and acts on the face of the aft seal helping the spring to press it against the shaft. These two systems may mix as the seal faces wear. The latest system incorporates two clamped halves which can be split to facilitate overhaul whilst afloat.

Once again Fig. 6.12 is self explanatory.

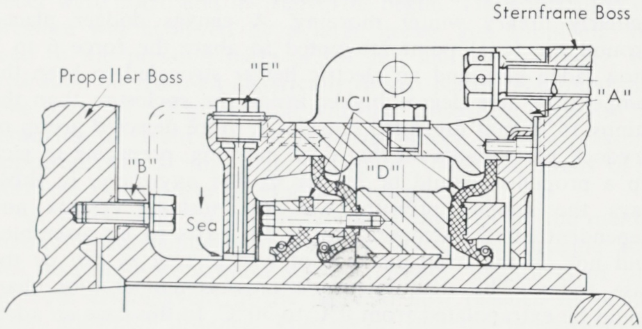


Fig. 6.12

Outboard oil gland seal.

Part "A" of the assembly is the "stator" attached to the sternframe boss and bush.

Part "B" to be bolted to the propeller and rotates.

There are three pre-formed, garter spring loaded, synthetic seals at "C".

Two items are slightly different this time:—

(i) Oil in annulus "D" does not have pump circulation to cool the area as the sea water is thought sufficient cooling.

(ii) There are two dipsticks top and bottom at "E" for taking the weardown of the aft whitemetalled bush.

These plugs can be removed and the poker gauge screwed into the space from which the weardown distance can be read. During newbuilding these top and bottom readings are taken and printed on the lid of the instrument box which is kept on board. A note is also made on the F.E. Report 4 (Inst.) Part 1, Sheet 2.

The centralizing when fitting of this outboard seal is also achieved by the circumferentially pre-machined shoulder.

A Note about Weardown

Although the Instructions to Surveyors give some idea of allowable weardown for lignum vitae it is difficult to find limits for whitemetal oil-lubricated shafts. Ship colleagues at this port have been advised that the normal shaft clearance entering the sternbush when new, is 0,9 to 1,0 mm during building, for an 800 mm diameter shaft. "Excessive" leakage of lubricating oil from its oil header tank in the engine room would possibly commence at 1,5 mm and the maximum gap before bush renewal could be in the range 2,0 to 2,5 mm. To actually slide a feeler in and check this is difficult without removing the gland and so the oil leakage and poker gauge readings must suffice as evidence of wear. On smaller vessels the propeller can be jacked up with a clock-gauge mounted on top and the clearance or lift relative to the pull read off the gauge.

Of Particular Interest to the Surveyor

The following questions on the Rpt. 4. (Inst.) Part 1. Sheet 2 can be completed.

(i) Screwshaft diameter at large end of cone:—

On the report this reads "Diameter of 'propeller cone' at large end, or in body, if flanged shaft". As these measurements can be different, it is better to fill in both sizes to avoid any confusion should the shaft require to be machined at a later date, due to corrosion.

(ii) State type of forward coupling (e.g. solid, muff, etc.). The material and tensile strength.

(iii) If an approved type oil gland fitted, state name.

(iv) Give original poker gauge readings top and bottom.

(v) Although shafts do not have liners these spaces are completed (i.e. no liners).

(vi) The seal markings, if any, having been verified with their certificates, if available, can be noted on the sheet "List of Certificates". The inclusion here is also appropriate for sternbushes (H 236(b)) and tail-shaft although the last two are noted on the Rpt. 4b Cons. Cont.

PLATE 6.9

Tailshaft poker-gauge readings being taken (top).

PLATE 6.10

Tailshaft poker-guage weardown reading being taken (bottom).

(vii) The material and tensile strength of screwshaft are entered under the heading tubeshaft as there is no requirement for this information under the heading screwshaft.

Plates 6.9 and 6.10 show the poker gauge readings being taken top and bottom.

Plate 6.11 gives a good idea of the general area and height at which poker gauge readings are measured and shows a Surveyor obtaining them.

(e) **Fitting of the Propeller and Pilgrim Nut**

SLIGHTLY HISTORICAL

The Author has had the opportunity to follow the progress of fitting key-less assemblies since early 1968. In that year at a particular shipyard there was a key-less propeller fitted using the Bunyan method. The propeller had a special cast iron insert located in the bore. This was locked and pinned in place with threaded dowels at its aft end. The pilgrim nut was screwed on the shaft and the propeller, after being liberally smeared internally with Bardahl, was jacked up[1]. Described thus it would appear very straightforward. However, the actual fitting of this particular propeller was one of the more traumatic experiences and a definite milestone of the Author's surveying career. As such it is thought to be worthwhile describing the event a little more fully and in so doing give a comparison between early 1968 and present-day methods.

The complete event took place high up on a staging as can be witnessed in Plate 6.11. Due to exigency of production it was necessary to begin operations at 0400 hours on a particularly dreary winter morning. A canvas dodger placed around the focal point attempted to abate the force 6 to 7 snow-laden gale and an electric heater struggled to keep the temperature one degree higher inside the enclosure than the minus 16°C that prevailed outside. A more dejected group of drydock participants on that dark morning, preparing to jack up a propeller, would be harder to find anywhere. In those days the applied pressure was the push-up criteria and dependent on the temperature of the parts to be assembled and not on the fixed distance of a steel ring as can be the case today. The manufacturer's pressure-temperature chart could be extrapolated from 0°C to 30°C. In this case an additional grubby piece of paper sufficed to allow the line to be decayed to −16°C and from this the pressure of the day was decided upon[2]. Relevant marks on the tailshaft and pro-

[1] Due to the fact that the internal bore of the propeller was not expanded, as is the case today, the end pressures were very high. The final press-up was in the region of 2500 kp/cm^2 in comparison to the allowable 600 to 700 kp/cm^2 of today. As the pressure is circumferential as well as linear, expanding nuts were the order of the day. An excellent description of nut thread loads has been written in a prior paper.

[2] When the parts are cold the pressure is due to contraction of the propeller mass.

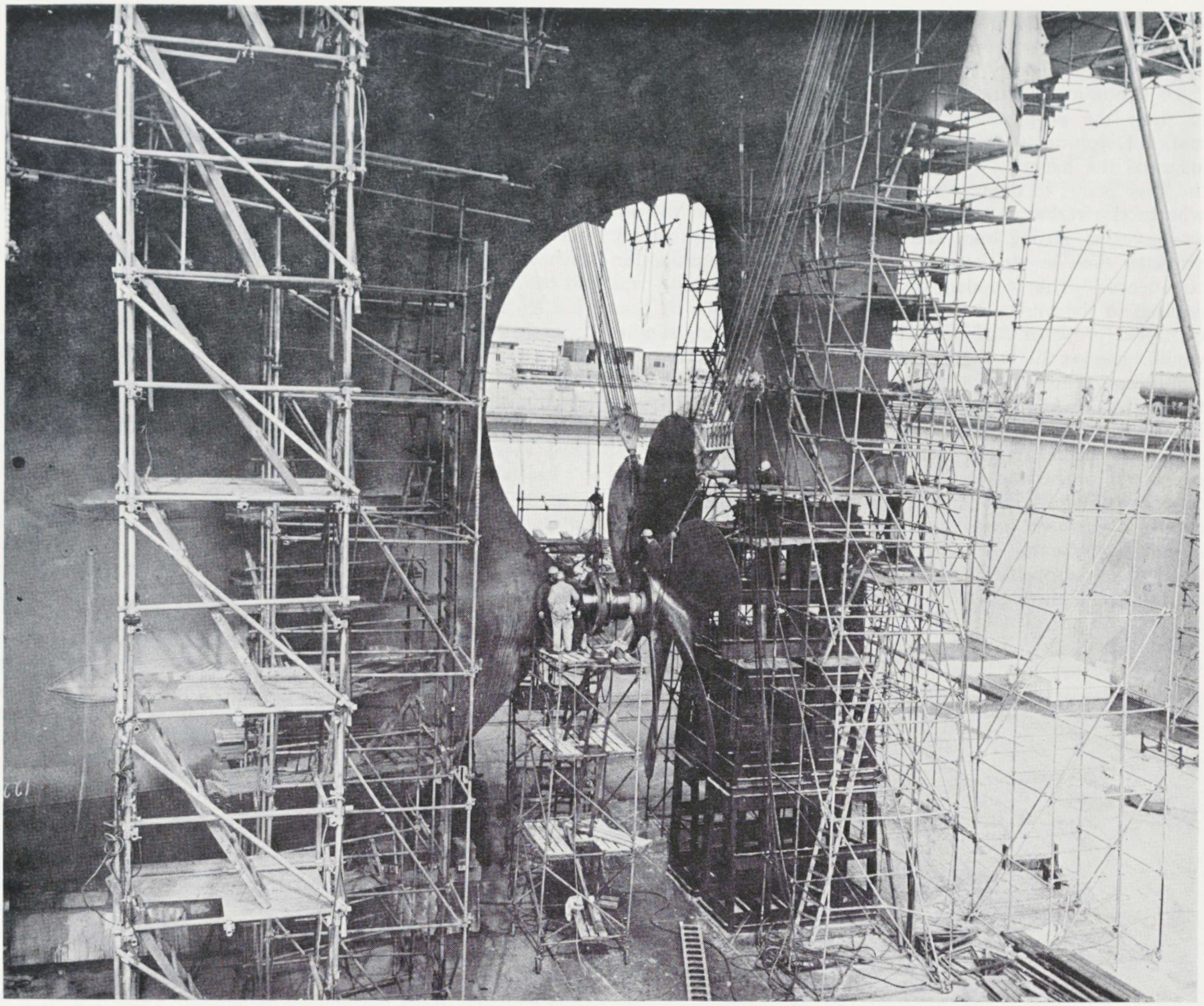


PLATE 6.11

Six-bladed propeller with oil seal draped around the tailshaft with a Surveyor in attendance.

peller were noted and the rigmarole begun. The application of pressure was achieved by a large grease gun supplying the feed to the pressure parts of the nut and not as today, by hydraulic oil from an electrically driven pump. The interminable filling of the grease gun with the subsequent necessity of removing air from the nut internals before positive pressure appeared, was at this time and under these conditions of a northern Europe winter, soul destroying.

An initial push-up was achieved as required by the manufacturer's instructions after only a few hours' struggle and this was considered quite good. However, the travel of the pressure arrangement in the nut had now reached its maximum allowable distance. This meant that the pressure must be released, pressure components part evacuated of grease and the nut followed up until the faces of propeller boss and loading piston became flush again. By this time the extremities of essential human limbs were beginning to show signs of frostbite, so precluding further effort. Although the initial mark had been achieved the final point at the large end of the cone, approximately 16 mm further up, giving a total length of 21 mm seemed far away relative to the time spent achieving the initial point of no return. Defeat by the elements was finally conceded as interest was at a low ebb and the vote for a temporary respite carried unanimously. During this period it became apparent why the more fiery translucent liquids are distilled in these climes. As internal anti-freeze they are not only good but essential to survival at times like this. After a while, when all participants were reasonably sure that personal appendages had not been affected by frostbite, the quorum was once again reassembled around the propeller. The grease gun was reloaded and decontaminated of air and final press-up begun. (The description press-up is rather misleading. The

tailshaft is actually pulled through the stationary propeller bore as it is free to move, the inboard end is not coupled and only centralised lightly by jacks.)

To continue with the sequence of events: As dawn began to show the propeller jammed 4 mm from the workshop marks. Dejection was complete. The Author's lack of knowledge of the language at that time precluded understanding the finer points of descriptive rhetoric, however, the assembly withstood a verbal pounding that morning. Eventually the nut was reversed, strong back and holding rods screwed into the propeller boss as required and jacking-back for examination commenced. The wooden distance piece (Fig. 6.14) was omitted in the misery of the occasion and when the 57 tons of bronze propeller came free suddenly the resounding ringing would have set the late sexton of Notre Dame chuckling with admiration. The fact that nobody had heart failure or fell off the platform when the propeller released is amazing. It would be well to remember the piece of wood in future cases. In conclusion it can be related that late the same evening the propeller was pressed-up to the required marks with a pressure of approximately 2500 kp/cm^2. A member of the shipyard control department has since witnessed dismantling of such an assembly containing a sleeve and relates that the removal required the propeller boss to be drilled to its full depth to the tailshaft, this being for the injection of hub expansion oil to facilitate the removal of the propeller. Possibly this was the start of boss injection, but I feel sure the Rotterdam Surveyors can give a fuller description of the event.

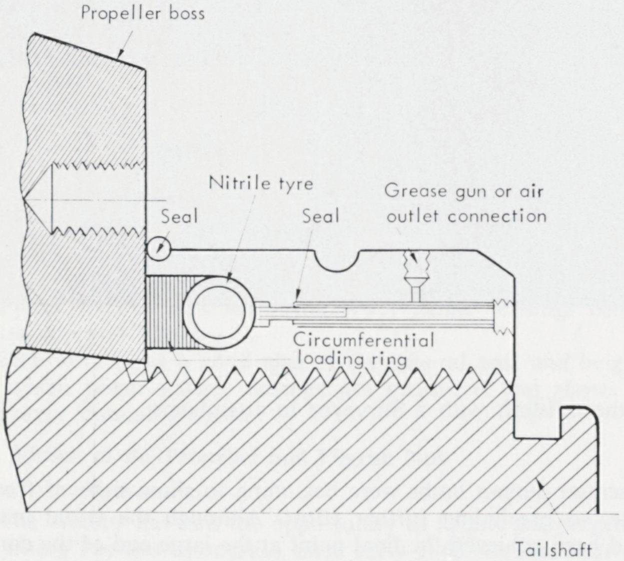


FIG. 6.13

Press up.

Fig. 6.13 shows the jacking-on procedure and Fig. 6.14 the jacking-off procedure with the nut reversed for removal of the propeller assembly. Although the figures are diagrammatic and reasonably self explanatory, a short description is thought appropriate and of possible interest. Surveyors dealing with these problems sometimes do not have the opportunity to see the internals without making some prior effort, as when the Surveyor is called to witness the pull up, the assembly is in place and ready to operate and as such it is difficult to study.

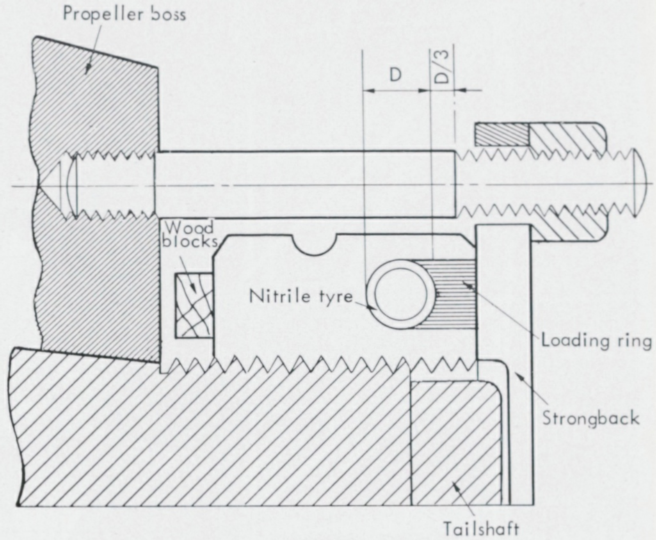


FIG. 6.14

Dismantling.

In the jacking-on assembly, as shown above, the travel of the loading piston is one-third of the diameter of the nitrile tyre. It is therefore essential to tighten the nut up manually to the start point and this should be within the limit of travel of the piston, normally about 25 mm or more for more recent cases. The threads of the tailshaft and nut are smeared with a molycote grease prior to assembly. When the mark on the shaft or prescribed pressure has been attained the nut is then drained and locked in position. The assembly is marked for future reference as described later.

It should be remembered at this time that drydock on site work is being dealt with and not initial shop calculation and fitting.

Fig. 6.14 shows the dismantling arrangement and the nut reversed. The wood block limits the jump travel of the propeller when it comes free. The whole system is both ample and effective under present-day conditions using hydraulic oil boss injection and the strongback need not be used, relying solely on the boss expansion.

Fig. 6.15 shows a similar arrangement using another make of nut and distance washers being the travel limit rather than pressure and marks at the upper end of the cone.

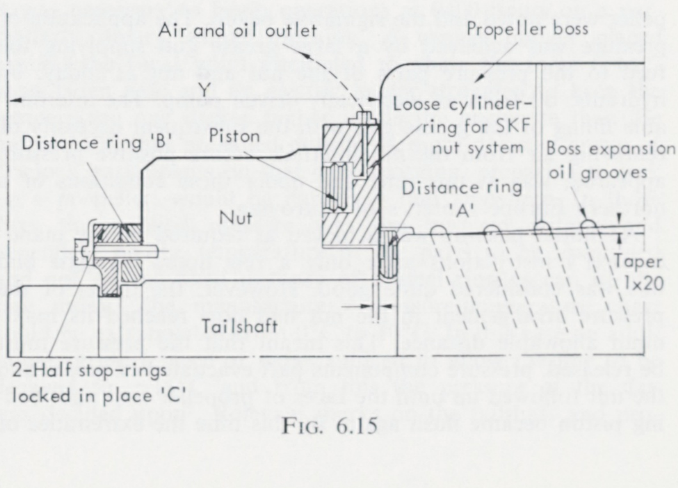


FIG. 6.15

Fig. 6.16 shows the initial assembly prior to injection of oil. The nut has not been tightened by mechanical means as yet. On one occasion it was decided to use one pump for simultaneous hub and nut assembly pressures. The gap shown at the bottom was thought to be reasonably small and the pump started. The unexpected bath in Shell Telus 15 was not appreciated and two pumps have been used subsequently. It is, therefore, that the nut is hardened up mechanically to a start point, which gives a reasonable oil seal around the hub. If the jack is used for this purpose and reaches its piston travel limit, it means disconnecting oil pipes to turn the nut further up the thread. The travel of the Pilgrim nut is one-third the diameter of the tyre or about 25 mm. The travel of the S.K.F. nut is about 35 mm and the average propeller pull-up distance is 22 mm. In this particular yard at Odense the assembly crew preferred the latter system as the former was very close to its travel extremity and can require laborious adjustment at times, as already described. (The travel has been subsequently lengthened. In early days it was only 7 mm.) The manufacturer's marks are noted and a mark scribed 10 mm further up the shaft. This is in case the first scribed line should be lost under the propeller boss and then one does not know what has happened. Slight pressure (50 kp/cm²) is exerted from the nut piston and noted, and then pressure applied with a second pump on the boss. These two pressures usually follow one another very closely, the nut pressure normally lagging behind the boss pressure.

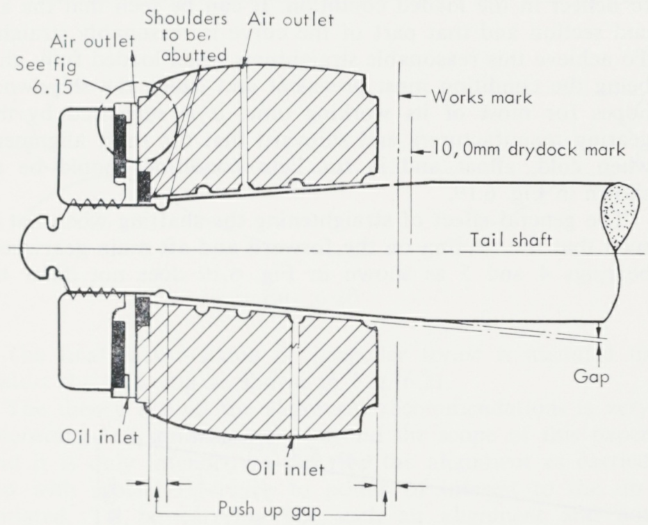


FIG. 6.16

Start point.

Fig. 6.17 shows the distance marks and the tailshaft when pulled through the propeller boss. The piston is extended and the distance washer and tailshaft shoulder have abutted. This phenomenon can be witnessed by a sharp rise in the oil pump pressure as they meet and the distance "y" shown in Fig. 6.15 is the only means of verification with the scribed line at the top of the cone at this moment. The oil pressure on the hub is allowed to fall off but the nut pressure should be maintained for about half an hour. This allows oil to drain off the hub and the grip to become firm.

Fig. 6.15 shows the complete assembly with the piston deflated and distance washer "B" and stop ring "C" locked in

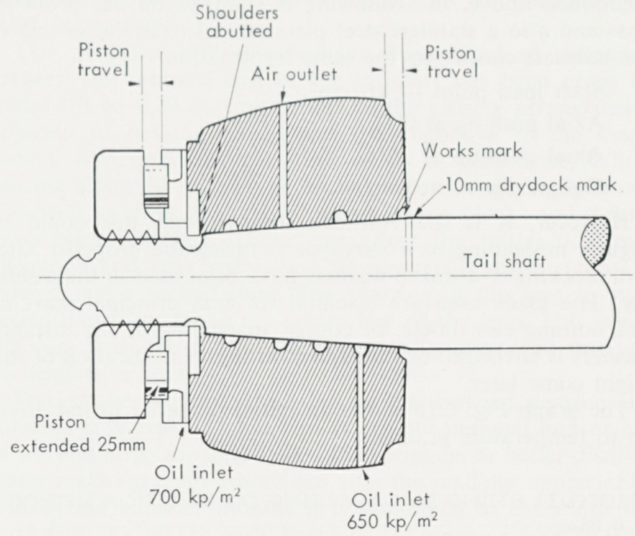


FIG. 6.17

place. The ends of the tailshaft nut and propeller are marked as requested in the draft of Instructions to Surveyors Keyless Propeller Assemblies 26th October, 1971. A marking has been established as shown on Plate 6.12. As requested in the draft

PLATE 6.12

mentioned above, the following is stamped on the propeller boss and also a stainless steel plate affixed to the after end of the tailshaft containing the same information.

Start load point — kp/cm².

Axial push-up at 0°C.

Axial push-up at 35°C.

Design shp — at rpm —.

However, it is the Author's opinion that this could be slightly misleading to a Surveyor re-fitting the propeller after a drydocking if distance washers have been used in the assembly. The loads used are essential for first principal marking and nothing else unless, of course, machining of the distance washers is envisaged at subsequent fittings. Clarification of this might come later.

The graph Fig. 6.18 shows an initial propeller fitting drive-up to temperature gradient.

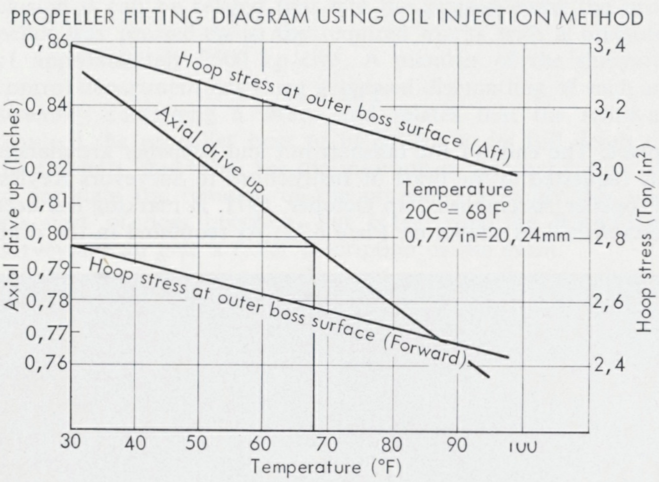


FIG. 6.18

(f) Alignment of Shafting and Chocking

The problems associated with shaft alignment (and problems there are) on board one of these V.L.C.C's is reminiscent of the medical professions' attempt at truthfully diagnosing the cause of the complaint known euphemistically as a bad back. The premises pertaining to the problem are numerous but indefinite; so is the case concerning shafting, gearing and turbine alignment on board aft end machinery tankers. One would assume that the shaft length would lie in a straight line, however, this is not the case. The diagram below shows how the shafting sits when in the cold and uncoupled condition with actual initial flange-face and rim clearances given.

Although the three flange-rim offsets shown above, of 0,9 mm tailshaft to intermediate shaft, 0,40 intermediate shaft to thrust shaft and 0,82 thrust shaft to gearing are sketched as being the differences of the centres of the flanges they are obtained practically at the coupling rim. The detail indicated may be of value to clarify this point.

Should a V.L.C.C. with this alignment enter drydock, the shafting flanges be disconnected and clearances taken and found as indicated an unsuspecting colleague could reasonably surmise that the ship had suffered a bad grounding astern or that the dock keelblocks were incorrectly aligned and causing d.b. deflection, but this need not be the case at all.

The theories, or it might be better to say some of them, concerning alignment can best be described diagrammatically.

Fig. 6.20 shows how the complete propelled box is thought to deflect in the loaded condition. It can be seen that the aft end section and that part of the curve is reasonably straight. To achieve this reasonable straightness when loaded fully, this being the condition most prevalent and which the shipowner hopes for most of its working time, it is suggested by the gearing manufacturers and shipyard that the shaft alignment when cold, afloat and in the light condition should be as shown in Fig. 6.19.

The general effect of straightening the shafting when hot is such that the loading on the forward and aft main gearwheel bearings 4 and 5 as shown in Fig. 6.19 does not differ by

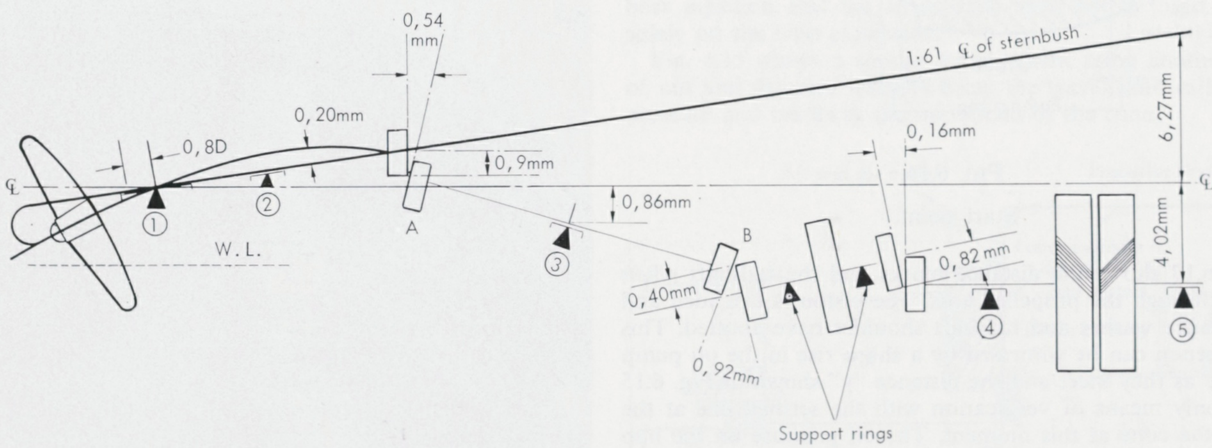
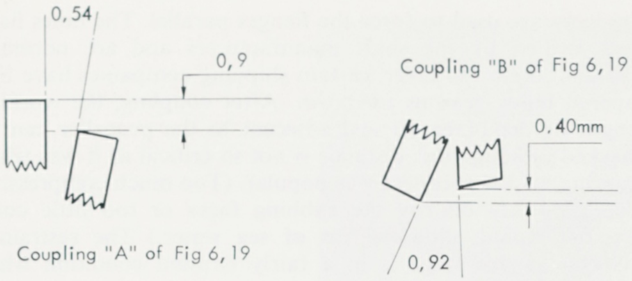


FIG. 6.19

Initial shafting alignment.



Detail of Fig. 6.19

more than 145 kN (14·5 ton f). The five bearing loads will be shown later in tabular form for hot and cold conditions.

The main factors thought to influence the shaft coupling flange angles are as follows:—

the thermal expansion of gearing and turbines,

the turbine baseplate deformation due to crossover pipe forces (Ref. 3),

the "turbine baseplate" deformation due to steam inlet and bleed pipe forces,

"Foundation" deformation due to crossover pipe force, oil tank thermal expansion (Ref. 2),

hull deformation due to water pressure, ship load, temperature and waves, and

hull deformation due to propeller thrust and gear torque.

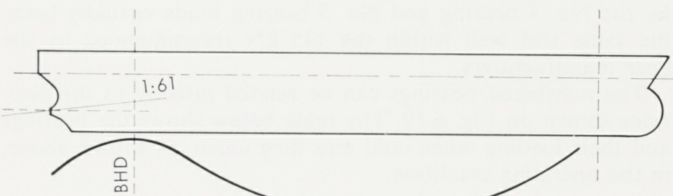


FIG. 6.20

The final factor stated of propeller thrust is assumed to distort the tank top as shown in Fig. 6.21.

The theory behind the alignment recommendations is very interesting but unfortunately beyond the scope of this paper and it is only intended to describe the alignment as carried out with special reference to points of interest to the uninitiated. To be carrying out such an alignment and not knowing any of the reasons for doing so is thought to be most frustrating.

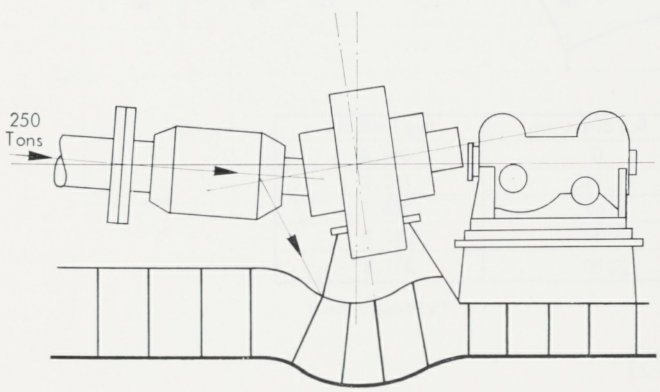


FIG. 6.21

The propeller and glands have been fitted as described earlier. The inboard end of the tailshaft has been given an initial lift of 0,20 mm by means of the jacking arrangements adjacent to bearing No. 2 and the alignment in the longitudinal horizontal plane is now ready to commence. Whilst passing along the quay to go on board for the shaft alignment, it is well to check that the propeller lifting blocks and tackles have been removed. These can affect the initial 0,20 mm clearance and may necessitate the complete alignment to be carried out a second time. The shafting in the port to starboard plane lies along the centre line of the ship. This is not the case with the turbine to gearing alignment, but this will be dealt with later.

During the progress of setting up the shafting, gearing and turbines it is essential that liquids are not pumped into or out of aft end large capacity tanks. Fuel bunkers or boiler distilled water make-up from ashore can alter the readings appreciably. During the summer months it is attempted to carry out the setting-up during the early hours of the morning 0400 to 0700 hours before the sun has time to heat one side of the large steel area of the ship and so cause deflection of the readings. (The building dock lies in the east-west line.) Manufacturers' tolerances are stringently adhered to although amendments to these can occur even in the same series of ship. The probable findings reported back from vessels and new calculations may be the reason for the amendments. However, it substantiates the opening statement that theory of alignment in general remains in a state of flux, although the pure theorists undoubtedly disagree with this.

The intermediate shaft rests on one bearing only, that being at position three (Fig. 6.19). This bearing is whitemetalled top and bottom. Prior to aligning the tailshaft flange to the intermediate shaft aft flange the top half of the bearing housing is lifted and a sheet of packing material inserted. The top half is then clamped down and a feeler gauge tried at the bearings forward and aft underside ends to ensure that the shaft lies hard against the full bearing length. There are jacks around the periphery of the aft and forward ends of the intermediate shaft and these are altered to give the readings required at flange faces and rim as noted in Fig. 6.19. On completion of this operation the single intermediate bearing casing lower half can be re-adjusted by means of its jacking screws to give the full bearing surface once again. Chocks can then be made to suit this gap between foundation stool and bearing base. The packing is of course removed.

The thrust shaft to intermediate shaft and gearing is aligned similarly by juggling with the jacking screws. The thrust shaft is resting on the thrust bearing block support rings. The tools used for gauging during alignment are a simple steel straight edge, feeler gauges and a torch. When the various gaps have been attained, as in Fig. 6.19, the chocks are made at a later date and fitted bolt holes drilled and reamered and their fit checked with feeler gauges. The pre-aligned gear-bearing centres to the centre line of the sterntube is also finalised at this time. The height is set at a prior date with the optical instrument and reference points already described. The chocks around the gearing base are shown as in Fig. 6.22. It will be seen from Fig. 6.22 that the chocks at the moment are only forward and aft on the centre line and port and starboard centre of the casing. Further chocks are fitted at the corners "x" after the gear casing has been distorted to give the required geartooth contact between the secondary pinions to

the bullwheel. The casing corner loading will be described later.

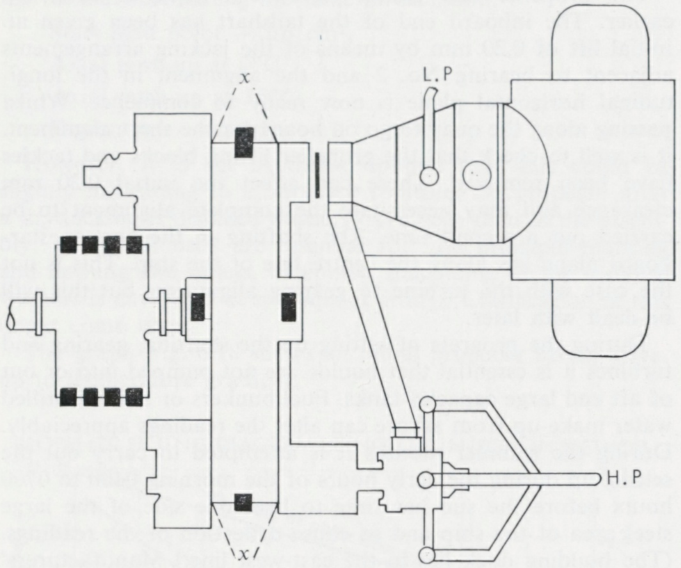


FIG. 6.22
Chocks.

Due to the time lapse between alignment and the steel chocks actually being made, fitted and made ready for checking, it is suggested that clock gauges with magnetic stands are placed across each coupling rim and set to zero. This enables a check to be made of movement due to clandestine filling of tanks. As previously stated, movement during a summer day can be observed although the gauges invariably return to zero after a period during nightfall. After completion of chocking the jacks are used to force the flanges parallel. The holes have been drilled by the shaft manufacturers and are normally parallel bored. However, certain shipping companies have had tapered holes, reasons unknown. After coupling, the working length of the outer oil seal adjacent to the propeller can be checked although this distance is not so critical as it was when a spring-loaded face seal was popular. (Too much compression would quickly destroy the rubbing faces or too little compression would allow ingress of sea water.) The restrained shafting at this stage is in a fairly stressed condition when cold.

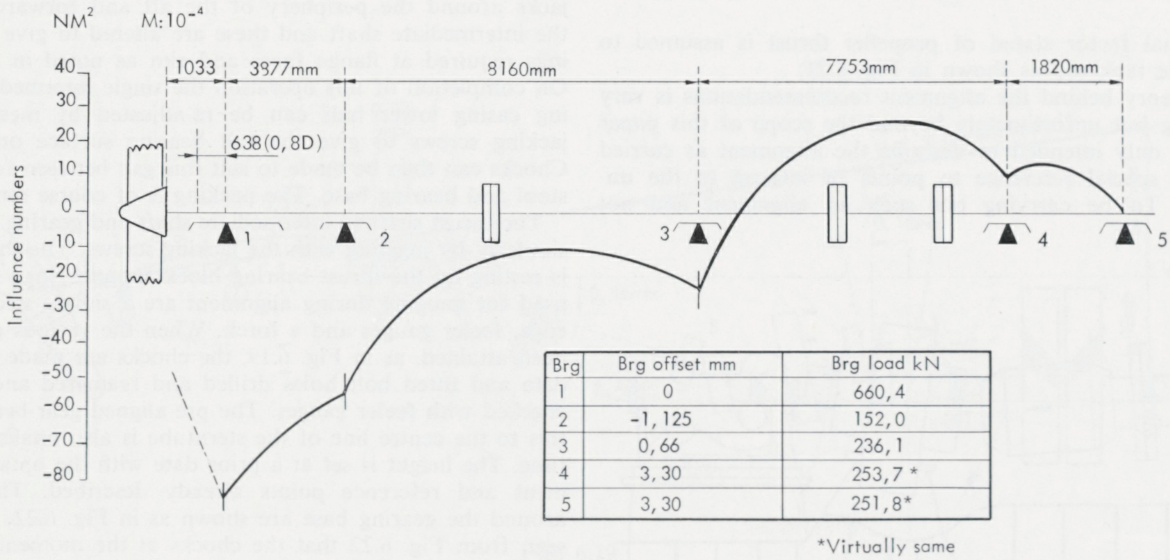
The alignment figures so far described have incorporated even further assumptions for thermal movement from cold to operating condition: —

Part Affected	Normal rise in mm
Intermediate shaft bearing	0,20
Main wheel, bearing foundation aft	0,36
Main wheel, bearing foundation forward ...	0,36
Main wheel, bearing pedestal aft	0,36
Main wheel, bearing pedestal forward	0,36

The hull temperature at normal operating condition is taken as 20°C and the gearcase at 40°C with a thrust bearing deflection due to the propeller thrust $0{,}350 \times 10^{-3}$ rad (*see* Fig. 6.21).

Fig. 6.23 shows the bending moments at operating condition and indicates that the object of the excercise has been achieved by the No. 4 bearing and No. 5 bearing loads virtually being the same and well within the 145 kN recommended by the gear manufacturers.

The numbered bearings can be related directly to the positions shown on Fig. 6.19. The table below shows the bearings and their loading when cold and then again, as shown above, in the operating condition.



Brg	Brg offset mm	Brg load kN
1	0	660,4
2	-1,125	152,0
3	0,66	236,1
4	3,30	253,7 *
5	3,30	251,8*

*Virtually same

FIG. 6.23
Bending moment at operating conditions.

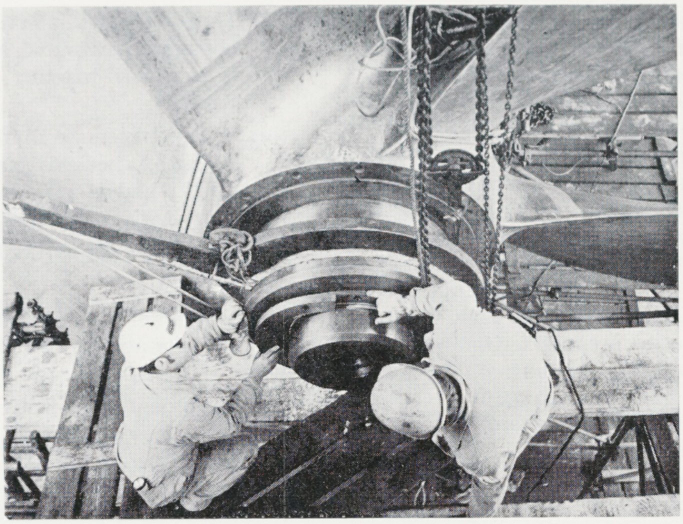


PLATE 6.13

Final hardening up of nut by conventional hammer and spanner with split distance keep-ring fitted.

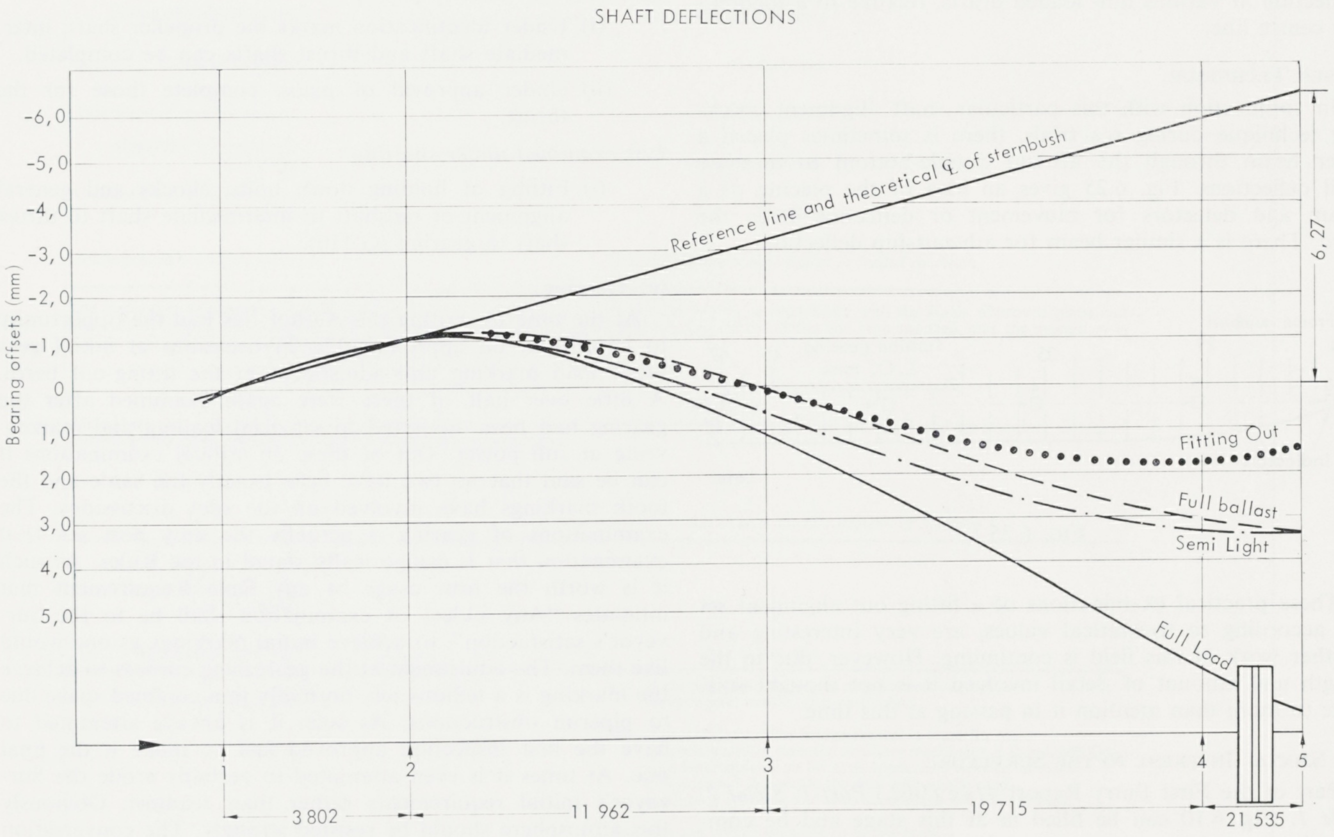


FIG. 6.24

To complete this section on shaft alignment it is thought to be of interest to describe briefly one technique used during sea trials to assess if the alignment has been reasonably successful. Sixteen strain gauges in sets of four are placed along the shaft adjacent to bearings but away from stress concentration areas. From measured strain values the bearing offsets and bearing reactions can be evaluated with a computer program and any deviation between calculated and measured values examined. The bending moment measuring positions at each shaft support are located in the same plane along the shaft centre line although each gauge of a set of four is at angles of 90° around the shaft circumference. In each of four gauges, those diametrically opposite are pairs. One vertical bending and the other, horizontal plane bending. At the start a zero reading is taken from the uppermost gauge for vertical moment. The shaft is then rotated 90° to obtain horizontal plane zero, then 180° from initial position for bending in vertical plane. A further rotation to 270° gives the position for bending in the horizontal plane. The magnitude of the bending strains is taken as the mean of four repeated measurements all observed under the same conditions. The bearing offsets and reactions are for the shaft under static conditions. For running condition, oil film effect at bearings and possibly eccentric thrust are taken into consideration, although with a six-bladed propeller giving very little thrust eccentricity these factors may not have too much effect on gear bearing loads.

A graphical interpretation of results (Fig. 6.24) shows shaft deflection at various hull loaded drafts, relative to a theoretical centre line.

Laser Technique

In conjunction with this particular shaft alignment checking technique during sea trials, there is sometimes placed a laser beam through the aft-end double-bottom to measure hull deflections. Fig. 6.25 gives an idea of the placing of a beam and detectors for movement or deflection from the zero. There is a similar beam for athwartship deflection.

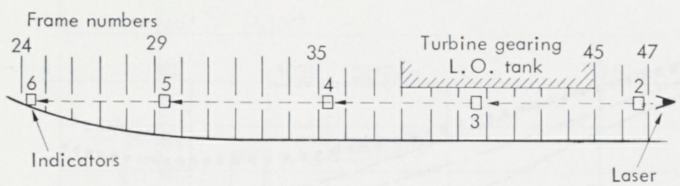


Fig. 6.25

These practical examinations of a fitting out alignment set up according to theoretical values, are very interesting and further work in this field is continuing. However, due to the length and amount of detail involved it is not thought suitable to more than mention it in passing at this time.

Of Special Interest to the Surveyor

Part of the First Entry Report *4/4a (Inst.) Part 1. Sheet 2. Side 1.* Fig. 6.10 can be filled in at this stage and be completed: —

(i) Maximum shp approved for each line of shafting can be obtained from approval letters and checked with the maker's information plate on the gear casing together with rpm of shafting and H.P. L.P. rotors.

(ii) Thrust shaft diameter adjacent to collar can be physically measured and checked with its certificate if available together with the material and tensile strength.

(iii) The intermediate shaft diameter, material and tensile strength checked physically and from certificate (H 221 and H 222).

(iv) The date and reference of torsional vibration approval and particulars of barred speed ranges if any.

This completes Part 1. (Inst.) Sheet 2. Side 1.

On *Side 2* of the above sheet (Fig. 6.26) can be completed the following: —

(i) Alignment of shafting; date.

(ii) Holding down bolts and chocks with date for gearing and shafting.

Rpt. 4/4a Part 2. Sheet 3. Side 1. (Fig. 6.32)

Under the heading gearing, the questions on: —

(i) Shafting and number.

(ii) Thrust—separate or integral, this is again duplicated in the box stating, "built in or attached" (Part 2. Sheet 3).

(iii) Output shafts.

Rpt. 4b cont. sheet (Fig. 6.7)

(i) Under identification marks the propeller shaft, intermediate shaft and thrust shafts can be completed.

(ii) Under approval of plans, complete those for the thrust.

List examined under shafting

(i) Fitting of holding down bolts, chocks and general alignment of tailshaft to intermediate shaft to thrust shaft to gearing (G 110).

(g) Gearing

At the time of writing the Author has had the opportunity to be present on approximately 24 occasions at initial gear tooth load marking and adjustment at the fitting-out berth. A little over half of these were again examined after the gearing had been subjected to sea trial loading and manœuvring at full power. Out of these 36 critical examinations it can be said that no two have been exactly the same and the tooth markings have involved on the spot discussions. The examinations of gearing is actually the only post sea trial examination that is categorically stated in the Rules. As such it is worth the firm usage of any Rule Requirement that intimates "Any object of examination shall be to the Surveyor's satisfaction", to achieve initial markings as one would like them. The adjustment at the gearcasing corners to achieve the marking is a tedious job, normally in a confined space due to piperun obstructions. As such it is always attempted to have the first inspection approved and so make it the final one. At times it is even attempted to verbally erode the Surveyor's initial requirements rather than readjust. Obviously this atmosphere should be resisted strongly. The conversation usually continues to an amicable end, incorporating one or possibly two further adjustments. Should the gear manufacturer's engineer have been at the shipyard longer than the Surveyor, which will be the case, as the contents of this paper are directed at the newcomer, this sets one off at an initial

PORT AND DATE OF APPROVAL OF PLANS

	Port	Date		Port	Date
Shafting except crankshaft			Cargo oil pumping arrangement		
Flexible coupling			Pumping arrangement at fore and aft ends of oil tankers and drainage of cofferdams and pumprooms		
Clutch					
Reversing gear and control			O.F. and cargo oil overflow systems where fitted		
Propeller including spare if supplied			Main steam pipes		
Air receivers			Boiler feed system		
Compressed air system			Main boilers		
Fuel tanks			Superheaters		
O.F. piping and fittings at settling and service tanks			Aux. boilers		
Oil burning arrangements for boilers			Domestic boilers		
General pumping arrangements			Feed water economisers		
Bilge, ballast & O.F. pumping arrangements in mchy. space			Steam heated steam generators		

DATES OF EXAMINATION OF

Fitting of stern tube		Alignment* of shafting	
Fitting of propeller sleeve		Testing of pumping arrangements	
Fitting of propeller		Oil fuel lines	
Completion of sea connections		Boiler supports	
Alignment* of crankshaft on board		Steering machinery	
Alignment* of turbines/engines and gearing		Windlass	
Holding down bolts and chocks		*State if aligned in light ballast or loaded condition	

The machinery reported above† has been constructed and installed under Special Survey in accordance with the Rules, approved plans and Secretary's letters. The materials and workmanship are good, the spare gear required by the Rules has been supplied, and the machinery is eligible in my opinion to be classed‡

All mill sheets and certificates have been sighted and I am satisfied that they relate to items installed on board and are in order. Copies of certificates for all essential items as per circular 2252 are attached.

Surveyor to Lloyd's Register of Shipping

A previous similar case was for (*name*)

Builder and Yard No.

Port & Rpt. No.

Date of Committee

Minute

†(a) If the installation contains any features of novel or experimental nature, give particulars

(b) If centralised and/or bridge control is fitted for main propelling and/or essential auxiliary machinery, a Rpt. UMS Gen. is to be completed so far as is applicable, whether or not it is intended to operate the ship with unattended machinery space(s), and is to accompany the F.E. Report.

‡Include any special notation to be assigned.

FIG. 6.26

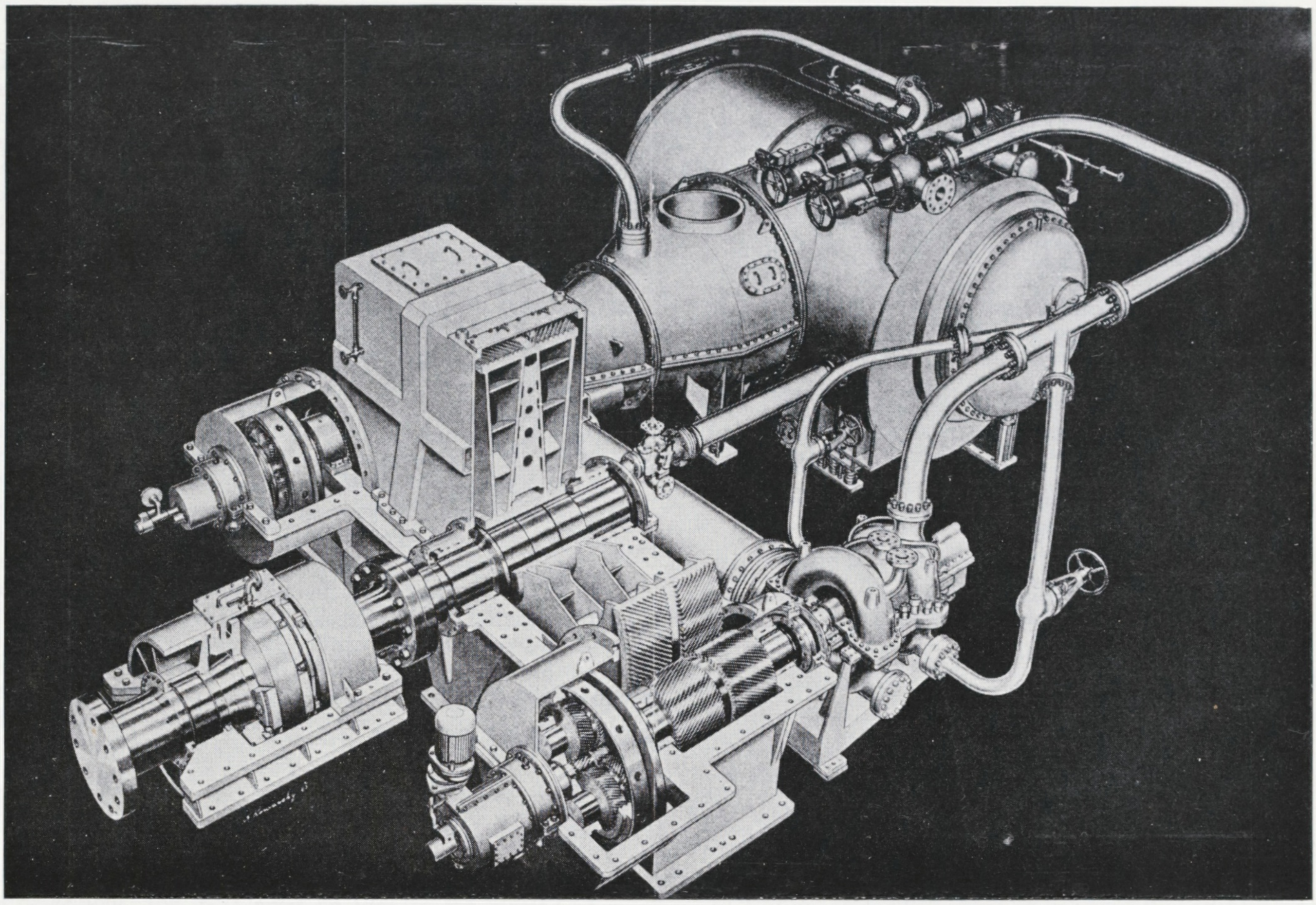


PLATE 6.14

disadvantage. It is hoped this short digression is sufficient to put the Surveyor, new to this work, in the correct frame of mind to scan the following notes concerning gearing.

Plate 6.14 shows a cross-section of gearing attached to the turbines and condenser. This type has been superseded and now a star gear is incorporated at the forward end of the secondary pinion on the H.P. side The assembly could be described as a "Triple Reduction, Star-Planetary-Parallel Gear". Fig. 6.27 shows a fully exposed set of gears capable of reducing the 6000 rpm of the turbine down to 85 rpm at the shaft giving 30 000 to 50 000 shp.

The gearing shown in Fig. 6.27 consists of three epicyclics in a combination of star gear at the forward end on the H.P. side pinion with planetary gears at the aft end of H.P. and L.P. pinions. As can be seen, the main wheel housing carries the overhanging weight of epicyclic and star gear on its secondary train. The main housing is flexible to give the initial gear tooth contact. This flexibility is slightly contradictory to one of our rule requirements on gear cases (H 311). A closer look at the difference between star, solar and planetary gears might be of advantage for future examinations as they are easily misquoted dependent on which part revolves and which part is stationary.

It might be of interest to interject a small historical note on gearing. It has been stated (Ref. 4) that the geared steam turbine started about 1910, lapsed and then revived around 1962. Single reduction gearing was discontinued around 1950 with the advent of high speed turbines using high pressure and temperature steam. Prior to 1946 it is believed the Society had no rules for gears, only materials from approved foundries.

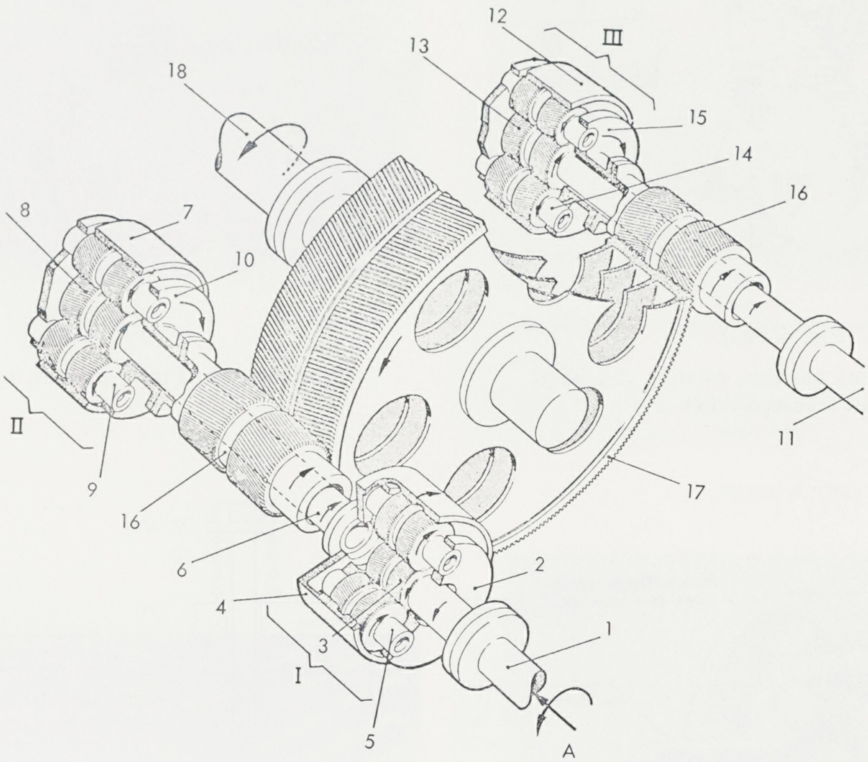


FIG. 6.27

HP PRIMARY REDUCTION

I. FIRST TRAIN (Star gear)

A. HP turbine input.

1. Turbine shaft.
2. Star carrier, fixed to the casing.
3. Sun-wheel, connected to the HP-turbine shaft.
4. Annulus (Internally toothed gear ring), connected to the low speed shaft.
5. Star wheels. These wheels revolve on the star-carrier spindles and engage with the sun-wheel and annulus.
6. Quill shaft.

II. SECOND TRAIN (Planetary gear)

7. Annulus fixed to the casing.
8. Sun-wheel connected to the quill shaft.
9. Planet wheels rotating about own spindles.
10. Planet carrier, connected to the pinion (second reduction) rotating in the same direction as the sun-wheel.

LP PRIMARY REDUCTION

III. FIRST TRAIN (Planetary gear)

B. LP turbine input.

11. Turbine shaft.
12. Annulus.
13. Sun-wheel.
14. Planet-wheel.
15. Planet carrirer.

FINAL REDUCTION
(Parallel-shaft gear)

16. Pinion.
17. Main wheel.
18. Propeller shaft.

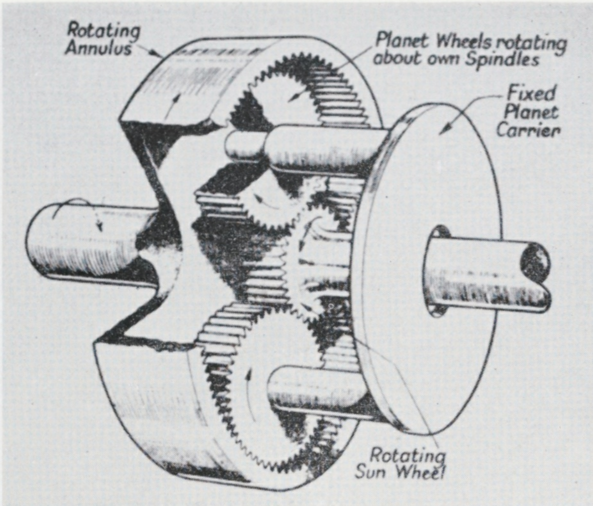


FIG. 6.28(a)

Star gear. Rotating annulus, rotating sun-wheel (not true epicyclic).

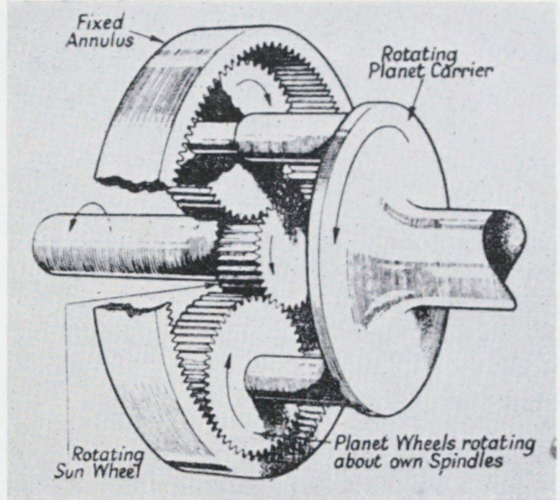


FIG. 6.28(c)

Planetary gear. Fixed annulus, rotating sun-wheel.

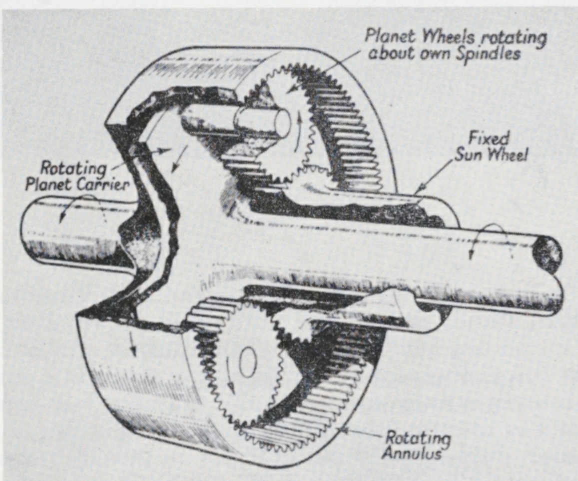


FIG. 6.28(b)

Solar gear. Rotating annulus, fixed sun-wheel.

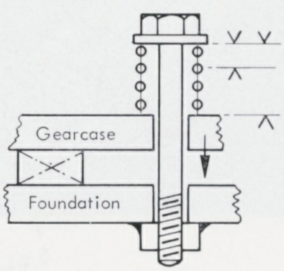


FIG. 6.29

Bending down.

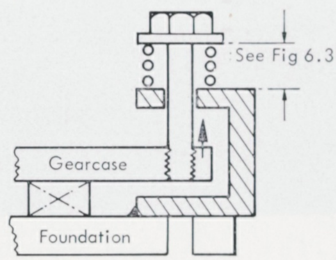


FIG. 6.30

Lifting up.

(i) Gear Loading

In this section, "Alignment of Shafting", Fig. 6.22 showed the position of the chocks under the gearcase and the corners were free at this stage. These corners are loaded by spring boxes, the compression distance of a known spring giving a loading in tons as shown in Fig. 6.31. Figs. 6.29 and 6.30 show the general arrangement of the two types of box for lifting or lowering each corner to suit geartooth markings.

Fig. 6.31 shows typical loading that can be expected. In this case the forward end H.P. was pushed down and the L.P. end pushed upwards. However, this can be reversed and is not standard.

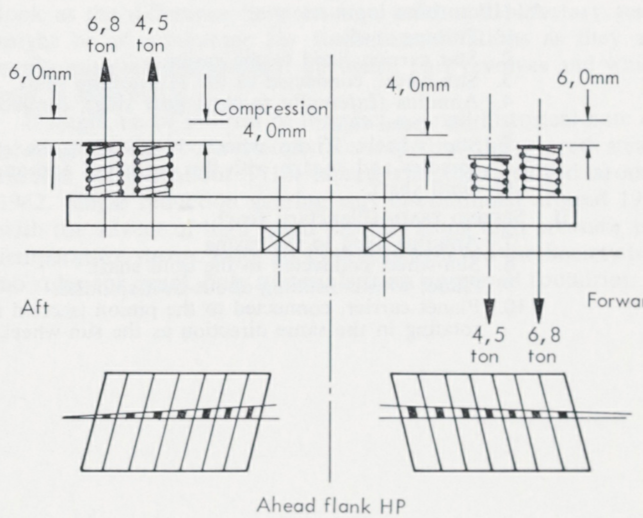


FIG. 6.31

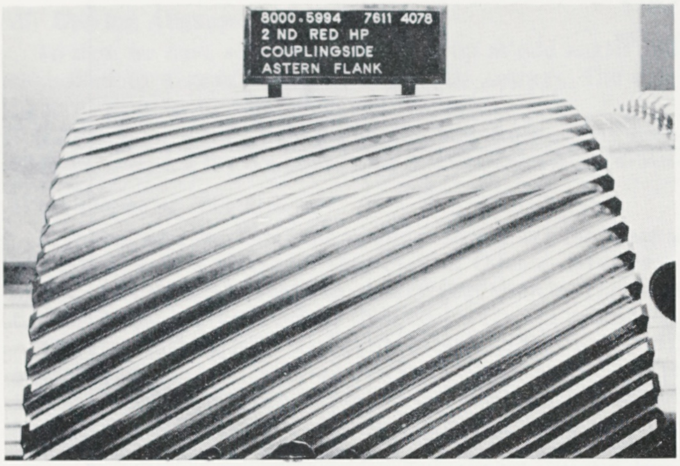


Plate 6.15

Astern flank.

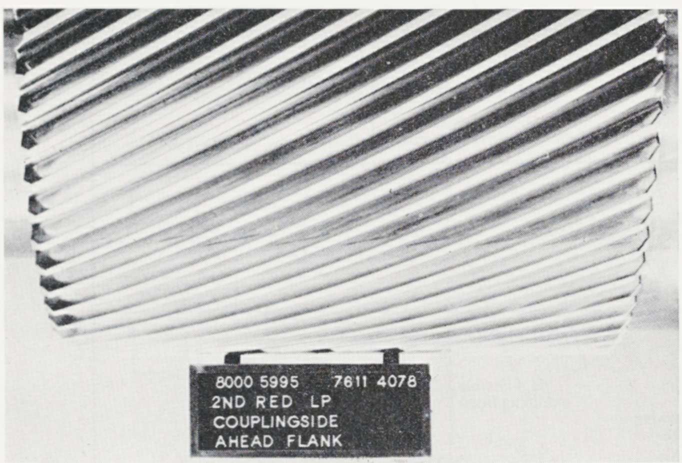


Plate 6.16

Ahead flank.

Plate 6.17 indicates two rubbings taken at the rolling alignment test in the workshop, which is similar to on board, giving a general idea of how difficult it is to judge when a suitable marking has been achieved and needs experience over a long period. As the newbuildings never return one does not have the opportunity to re-examine after a few years in service and so judge if the initial line up was correct. Colleagues in large drydocking or repair port areas could provide this information.

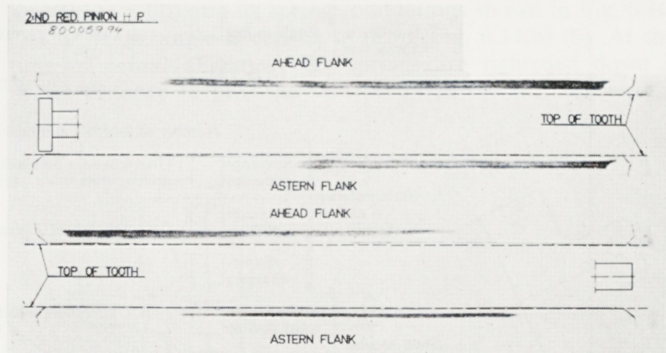


Plate 6.17(a)

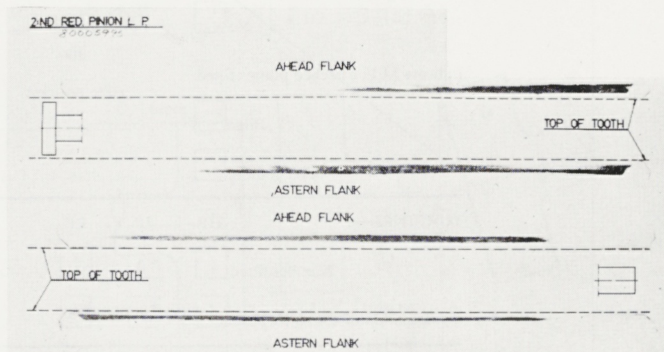


Plate 6.17(b)

Of Particular Interest to the Surveyor

(i) F.E. the date of alignment of turbines, gearing can be completed.

(ii) The section Rpt. 4. Part 2. Sheet 3—Gearing—can be completed.

Rpt. 4a/4b/4f (Inst)
Part 2 Sheet 3

Report on INSTALLATION OF MACHINERY—Part 2

Machinery items on board

Write clearly; this section of the report will be used for computer input data

Ship's name ...... LR No. ......

Port ...... Rpt. No. 1 Date of completing Report SEPT 73

Place an X in all boxes applicable to installation, or answer the question. Where inapplicable write N/A.

MAIN INTERNAL COMBUSTION ENGINES

Number of main engines ☐ Engine make and type ......

4SC ☐ 2SC ☐ SA ☐ DA ☐ Number of cylinders ☐ Number of crankshafts ☐ Number of camshafts ☐

Is cylinder formation: single in-line ☐ V bank ☐

Is engine of type: crosshead ☐ trunk piston ☐

Are opposed pistons fitted: Yes ☐ No ☐

Is camshaft drive by: Chain ☐ Gears ☐

Number of journals and bearings (include thrust if part of crankshaft) ☐

State number if engine fitted with: Scavenge pumps ☐ Scavenge blowers ☐ Super-chargers ☐

Give scavenge pump drive, crank, levers, etc. For lever driven units state cylinders, e.g. all, 1, 2 & 3, etc. ......

Give position of blowers/superchargers if not in F & A line ......

State number if engine fitted with: Crankcase relief devices ☐ Scavenge relief devices ☐ Oil mist detector ☐

Is a T.V. damper/detuner fitted ☐

Is a balancer unit fitted ☐

Are fuel injection pumps: Separate ☐ in blocks ☐ If in blocks, state arrangement ......

Is engine equipped to operate on HVF: Yes ☐ No ☐

Is an attached air compressor fitted Yes ☐ No ☐ If yes, state how driven ......

Is generator driven by M.E. Yes ☐ No ☐ If yes, state kW rating ......

Indicate M.E. attached pumps fitted

	state position		state position
Bilge ☐	......	F.W. cooling ☐	......
S.W. cooling ☐	......	L.O. circulating ☐	......
		Other (state duty) Include Xhd driven pumps ☐	......

TURBINES

	HP	IP	LP	~~Separate astern turbine~~
Number fitted	1	N/A	1	
Location of astern turbines	1	N/A	N/A	N/A

GEARING

Number of sets of gearing 1

Is gearing: S.R. N/A D.R. X epi-cyclic X

Indicate if any of the following items are built in or attached to set: Clutches N/A Thrust N/A L.O. pump X L.O. cooler N/A Main feed pump N/A Generator N/A

Is a reverse gear fitted: Yes N/A No X

Indicate number per set of: input shafts 2 output shafts 1

COUPLING

Is a flexible coupling fitted: Yes X No N/A

If yes, state type (rubber, etc.) and where fitted MUFF-CLAW-STEEL

State manufacturer's type (Vulkan EZ, etc.) X

SHAFTING

Number of lines of shafting 1 Number of shafts per line 1

THRUST

State if separate, integral with crank, wheel or elec. motor shaft SEPARATE

FIG. 6.32

(ii) **Gearing Alignment to the Turbine**

To date we have seen the shafting set up at odd angles and connected to a gearcasing distorted at its corners. The next stage of gear to turbine alignment continues: —

Rather than draw gearing and turbines fully it has been decided to sketch the couplings only.

High Pressure Turbine

In giving a general idea the readings shown are those actually taken from a particular ship built at Odense. Position 1, in Fig. 6.33(a), is the fixed secondary gear pinion. The H.P. turbine flange is a little higher than centre (2) and canted (3).

The H.P. turbine is to starboard or outboard of centre (5), however, on the next newbuilding this will be on the centre line for reasons unknown at present (although the amount of slewing of the turbine foundation and deflection of tank top is being examined at this time). Again the coupling is also offset (6). When adjusting to clock gauges on flange-face and rim this is difficult to visualise in the planes of position Nos. 2, 3, 5 and 6 relative to position 1.

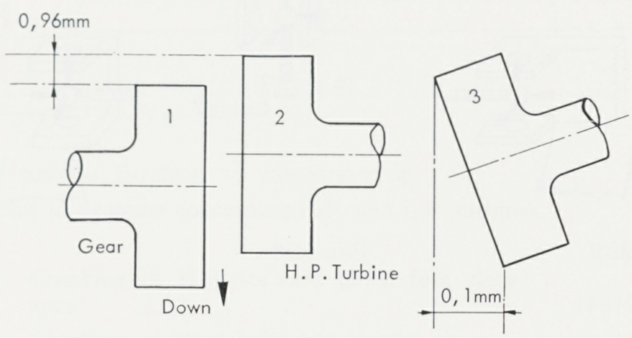


Fig. 6.33(a)

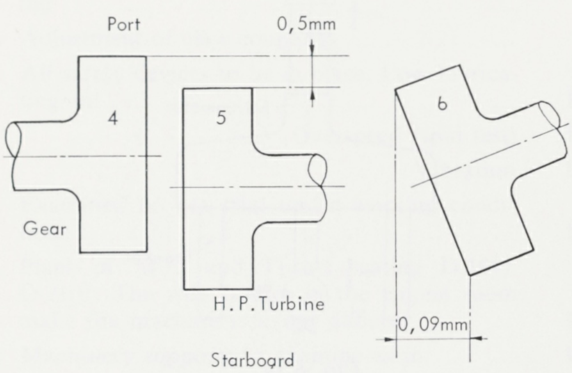


Fig. 6.33(b)

Low Pressure Turbine

The low pressure turbine sits lower than centre (2) and canted upwards (3) and continues with the flange (5) sitting outboard or to port of centre and once again canted (6). Concerning the complete alignment, in conclusion, if anything goes wrong, then to find the problem one could summarise with the phrase "the mind boggles". However, there are reasons, as one must imagine, for this initial alignment.

The tank structure under the bearing and turbine stools incorporates the lubricating oil tank. Measurements taken of the oil from cold to working temperature show that the steelwork stretches and lifts slightly.

The cross-over pipe from H.P. to L.P. when heated under pressure expands and pushes the H.P. turbine forward end outwards Fig. 6.33(b) (6). An experiment in which both ends of the cross-over pipe were blanked and then 4,5 kp/cm^2 of air was introduced clearly showed this stretching of pipe length. The expansion of the ahead to astern steam pipes above the turbine add to the movement effect. The main gearing bearings lift approximately 0,35 mm/0,5 mm as already described under "Gearing".

Concerning the L.P. turbine the weight of water in the condenser varies slightly and so causes the condenser to rise and lower a little on its spring foundations shown in Fig. 6.36.

The flange angle is caused to drop, Fig. 6.34(b) (6). At the time of initial alignment the springs are tightened down a preset distance to give the same drop as the working weight of water.

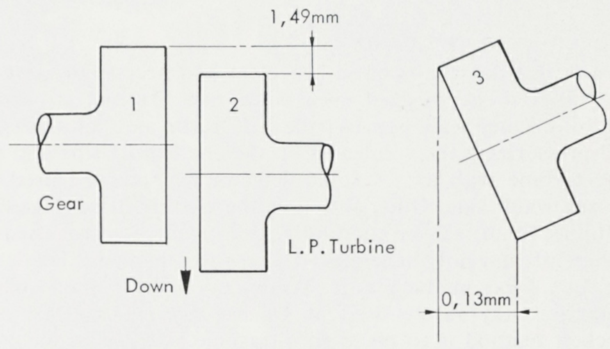


Fig. 6.34(a)

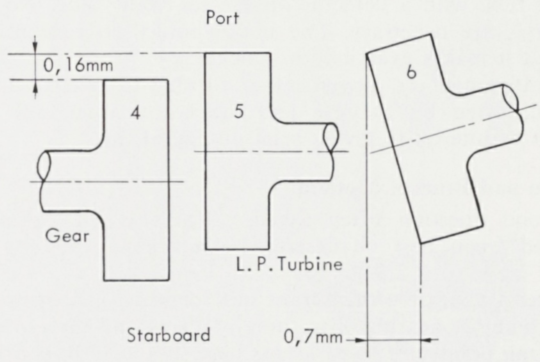


Fig. 6.34(b)

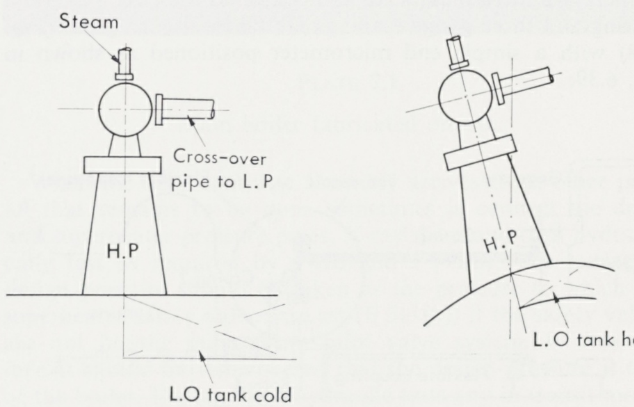


Fig. 6.35

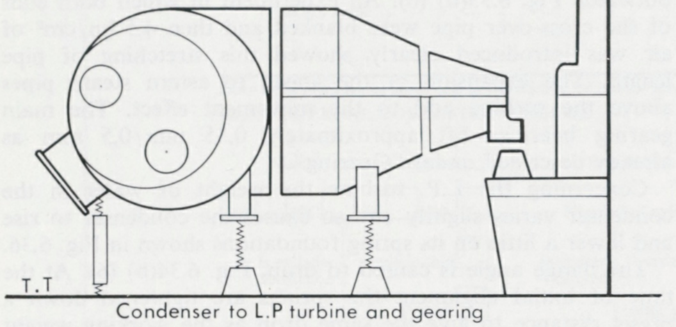


FIG. 6.36

A NOTE ABOUT THE CONDENSERS

In-transit damage is often prevalent and necessitates one or two tubes to be plugged even when new. Testing is carried out by placing seals between the L.P. rotor and stator casing and pressurizing the condenser on the condensate side and the L.P. turbine with air. A sonic detector can then be used on the sea water side. Other than this the electric driven vacuum pump (if fitted) can be run and again a sonic detector used or a sheet of thin polythene placed over the tube ends. The leaking tube sucks in the plastic. Water, fluoroscene and a black lamp are very rarely used at Odense now. The latest and quickest method is to place an ultrasonic vibrator in the condensate side and pick up the sound through the cracked or leaking tube with a detector on the sea water side. No seals or pumps are necessary. The initial outlay on equipment is high but it makes examination quicker.

The alignment or movement of turbine to gearing can be checked, often by the pin and bracket method, and it is thought of interest to give a brief outline of this.

(iii) Pin and Bracket Method

A good question often asked, "Where is the equipment mounted", can best be described diagrammatically by Fig. 6.37.

There is a flexible membrane seal between gearcasing and the turbine aft bearing. The three brackets and three pin-ball measuring points are fitted across here. Fig. 6.37(b) shows the simple arrangement.

There are three measuring points around the casing and end bearing and three gauge readings are taken at each point (Fig. 6.38) with a simple end micrometer positioned as shown in Fig. 6.39.

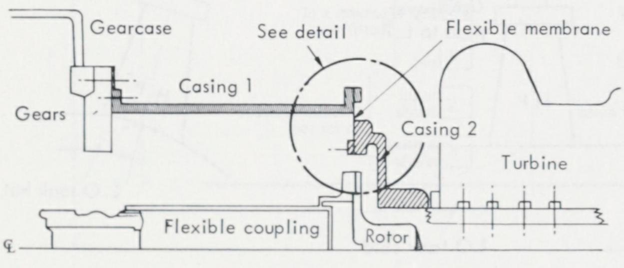


FIG. 6.37(a)

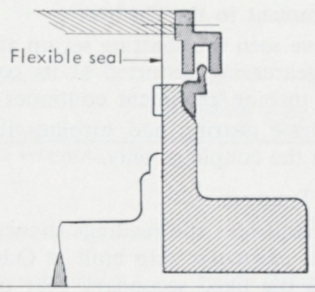


FIG. 6.37(b)

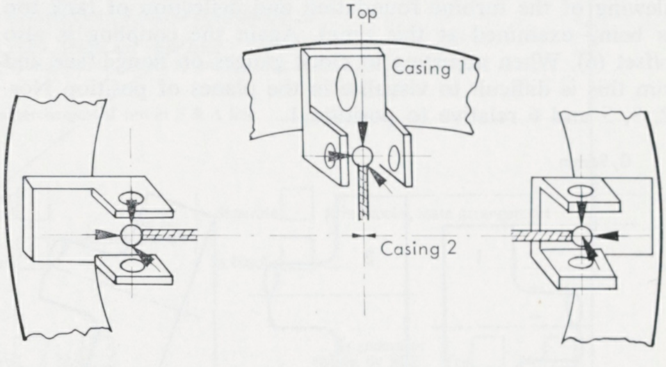


FIG. 6.38

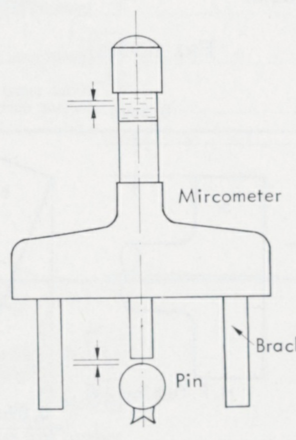


FIG. 6.39

These give readings to form a visual aid to indicate movement as shown in Fig. 6.40 raising and lowering movement and Fig. 6.41 showing the port to starboard movement in mm, again cold and at full power.

The most important thing to remember with pin and bracket method of alignment is the *neutral or reference point.* This *must* be taken directly after the initial clock-gauge alignment previously described. To wait for lub-oil filling and pipe connecting is too late. Due to the fact that the measuring points are floating but static (rather than rotating), readings can be taken relative to any draft or shp required and a complete picture of movement built up before, during and after the sea trials.

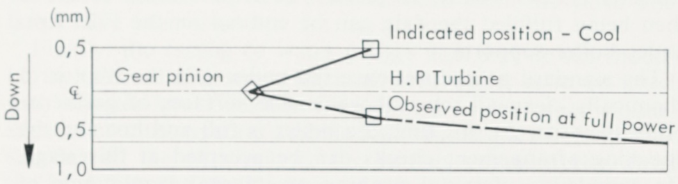


Fig. 6.40

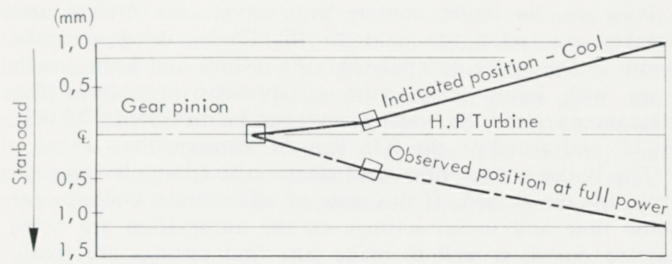


Fig. 6.41

Of Special Interest to the Surveyor

Items to examine concerning H.P. and L.P. turbines

		Rule
1.	Checking of H.P. forward guide foot clearance	H 810
2.	Checking of fitted bolts and chocks	G 110
3.	Alignment of H.P. and L.P. couplings to gearing	
4.	Adjustment of claw couplings	
5.	All safety devices to be in place. Low lubricating oil	H 831
	Overspeed (spin test)	H 829
	Vibration	H 841
6.	Examined on sea trial under working conditions	H 841
7.	Plans of M.E. and Thrust seating D 109/ D 2101. The web frames in the engine room make the machinery layout difficult	D 718
8.	Machinery supports to examine as in ...	D 5503
9.	Make sure there are certificates for items under G 103 or if they are noted on plans ...	G 104
10.	Check if the weardown gauges are on board	H 108

Condenser

12.	Alignment of feet and loading on springs ...	G 110
13.	Air test or ultrasonic test of tubes for in-transit damage	H 839

Conclusion

This completes all items concerning propeller, tailshaft, intermediate shaft and bearing, thrust shaft and bearing, gearing, turbines and main condenser.

7. Boilers: Main—Auxiliary—Stm/Stm Generators

Whether the Surveyors at Odense are fortunate or unfortunate concerning boiler construction is a debatable point. A certain amount of the constructions are fabricated within the confines of the yard by sub-contractors and so one has a chance to learn quite a bit about this subject. However, boilers arrive completed and fully documented from colleagues further up the line and as such it makes life pleasanter and the first entry form Report on Installation of Watertube Boiler 5.C. (Inst.) (Fig. 7.2) is easy to complete. Plate 7.1 shows such a completed boiler ready to be landed on the ship, and Plate 6.3 shows a main boiler in place, prior to further sections being added.

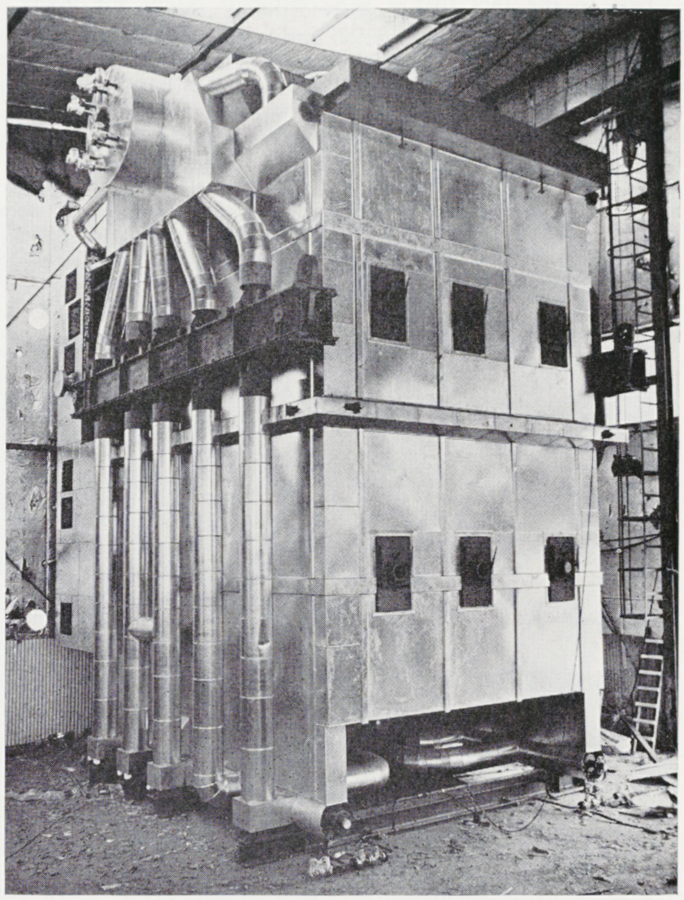


Plate 7.1

Main boiler fabricated on site.

When the near complete assembly arrives from other ports all that remains to be done sometimes is connect the drum and superheater pressure pipes, X-ray them and then hydraulically test as required by J 420 and J 445(b). The testing to design pressure should be taken as the pressure to which the superheater safety valves are set (E 511(b)) if the safety valves are not on the main drum pilot valve system. If they are then it should be remembered that the design pressure is that of the boiler. During these hydraulic tests any in-transit movements which might have caused tube leakage can be explored for, together with a look at the tell-tale holes drilled in welded

compensating pads, plates or brackets on the pressure parts (J 312) or supporting feet bedded closely to these parts to see if any leakage may have occurred through weld penetration or cracking. The blowdown line to the shipside can be tested at this time if pressure pumps and water are available (E 267/8) and this weld is usually X-rayed (J 623). If this blowdown and scum line go into one discharge, then there should be, but sometimes not, a S.D.N.R. valve in the line (J 624). Orifice plates have been utilised as continuous blow-downs. A certain amount of in-transit damage appears to be unavoidable and if the casing has not been fitted as in Plate 7.1 then tubes tend to be indented or gouged in exposed places. These can be repaired but should be in accordance with Q 708 or Q 108.

Due to the fact that a sub-contractor builds the boiler, whether it be locally or otherwise and the shipyard sets up a foundation in the engine room, a problem sometimes arises concerning the final connection of not always parallel mating surfaces.

Plate 7.1 shows the boiler on its "H" beam very clearly. It is sometimes better if a machine finished pad is welded underneath this which can then be mated to a similar pad laid on the engine room uneven deck level that is to take the boiler. Fig. 7.1 shows this and the demarcation line.

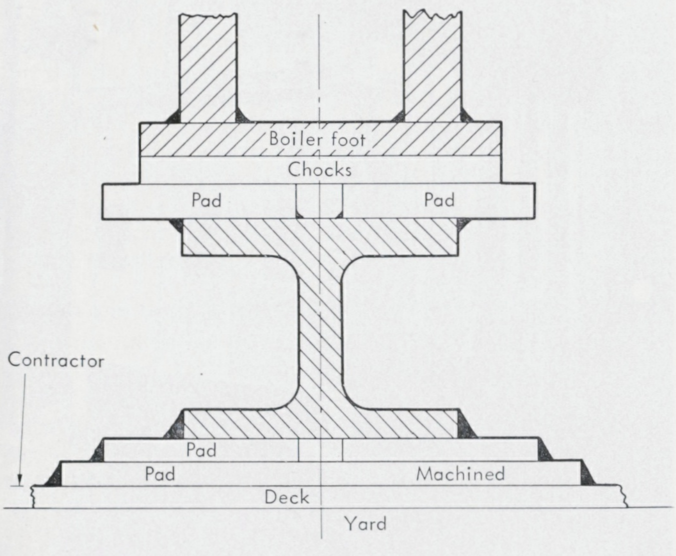


FIG. 7.1

These examinations can be said to come under the boiler foot and stool construction of D 2103. The chocks normally come with the boiler and at times these have been made up of many thin leaves of steel. However, it was impossible to make this type of chock bed down over the whole circumference and the aggregate of the clearances between each layer was quite substantial. It is therefore thought better to have a solid steel machined chock as shown in the diagram. These chocks are normally checked when the boiler has been filled with water to its working level and has been heated and expanded somewhat. The normal clearance as standard is 0,1 mm. At this time any greasing arrangements can be checked and the collision chocks welded in place. The requirements of C 110 then being fulfilled the date can be entered on the F.E. Rpt. under boiler supports.

The standard procedure, once the boiler is in the ship, is to chemically clean all internal water side surfaces of grease or other deposits. At this time the boiler is full and hot and the chocking arrangement checks can be accepted at this stage. On completion of initial cleaning, an internal examination of as many parts as possible prior to internals being added can be carrried out. This verifies all is in order and substantiates any boiler report building certificate comments. Once the internals are added access is very limited.

Prior to the boiler coming into service the firebox and uptakes are tested for tightness (E 332) by using a smoke bomb in the space or applying air pressure and testing each seam with liquid soap quite a laborious procedure. The clearances around the boiler casings can be measured (D 2105–E 331) and noted on the F.E. Rpt. 5C construction.

The boiler is then filled and steam raised initially using oil from the diesel tank. If this state of affairs must continue for some time and initial settings on the automation are being carried out, it is well to make sure that settings are recalibrated for bunker C in their entirety. Forgetting one automatic valve or item can cause hours of searching for the trouble. The recent directive from the Department of Trade and Industry (BOT) Notice to Shipping No. M 557 states that safety valves should be examined and adjusted on the first occasion steam is raised. As such the local powers-that-be at Odense, usually suggest this should apply to all flags and not only British, on grounds of safety. The setting of the safety valves (J 630) can be a laborious process if the groundwork has not been carefully prepared. A check list to the sub-contractors' engineers enumerating obvious things such as valve gags and a control manometer should be available. The setting usually takes place in the late evening when most trades have finished, for safety's sake, and it can sometimes be late morning before the job is completed. The valves are normally set to the stated interim certificate pressure but can be a maximum of 3 per cent over the design pressure (J 630) and then sealed with a lead seal (J 606). At this time safety valve drains can be checked to see they are over 19 mm bore (J 607) and they are led to a tank or other place, where high temperature steam 513°C can be safely discharged (J 628). The waste steam pipes should be 10 per cent bigger than the aggregate of the safety valves (J 611–629) and a steel rule can be laid across these whilst one is in the area. The supports and expansion joints of these steam uptakes can be examined under working conditions as the valves blow off. Although easing gear is not asked for in the section on water-tube systems (unless J 627 covers this point) it is recommended (J 606) for cylindrical boilers and steam/steam generators and as such owners usually wish to have them fitted. A recent case exists where the boiler could not be off-loaded quickly when the external attemporator valve joint blew, as the electrically operated valve on the superheater would not function. As it is necessary to off-load the boiler completely to renew this joint it was with the utmost difficulty that the valves were lifted by hand.

At a very early stage it is recommended to suggest that the yard obtains permission to waive accumulation tests (J 631). Carrying out such tests during sea trials on an 81 kp/cm², 110 ton/h evaporation boiler sends most participants to wait in the lifeboats. This accumulation test has also been valid for the steam/steam generators and the exhaust-gas boiler on

the diesel tankers we have commissioned from the yard. The latter have been tried but not the former.

Finally, the testing of water gauges and shut downs should be included at this stage. Each oil-fired boiler is to be fitted with a water level detection independent of any other mounting and it must operate audible and visible alarms as well as shutting off the oil supply to the burners automatically when the level falls (J 635). The trim of the ship affects this at times as the shut down is at the forward end of the drum, this being the end that will starve first when the ship is normally loaded and slightly by the stern. Under building conditions the ship is sometimes by the head and as such the lowering of water level to activate forward positioned alarm would starve the aft bank of tubes unduly. This low level detector (L 304) is to shut off the fuel to the burners. Other shutdowns such as flame failure (L 304(b)) should have the purge cycle time checked (L 304(c)). Unfortunately, this timer can be altered by ship's staff when the ship is in service. The staff say that sometimes they wait three minutes and then the "fail to ignite" alarm goes. A further three minutes is required and this length of time in places such as the congested English Channel is dangerous. Whilst dealing with level gauges (J 633), one should see if they are accessible and visible J 616. Visible from where? in a UMS ship with a control room under the boiler, is a good question. It requires long distance reading glasses which are not too reliable or a system of mirrors which become steamed up just when one needs them.

The testing of these level alarms requires the water level to be adjusted and the hand-operated valves can be tested from the convenient position wherever that is (J 637).

Finally, check the battery source of power for the burner control is in order and the charger connected (M 1308). A recent shutdown panic showed that this had been forgotten. The batteries were flat.

Plate 7.2 shows a tangentially fired main boiler being constructed locally for placing on board a ship to the Society's Class early in 1973. Plate 7.3 is the small auxiliary boiler for the ship. It is called auxiliary, although it can give steam to the main engines to bring the ship home at 5 knots. The air heaters are normally of the rotary type and only recently are

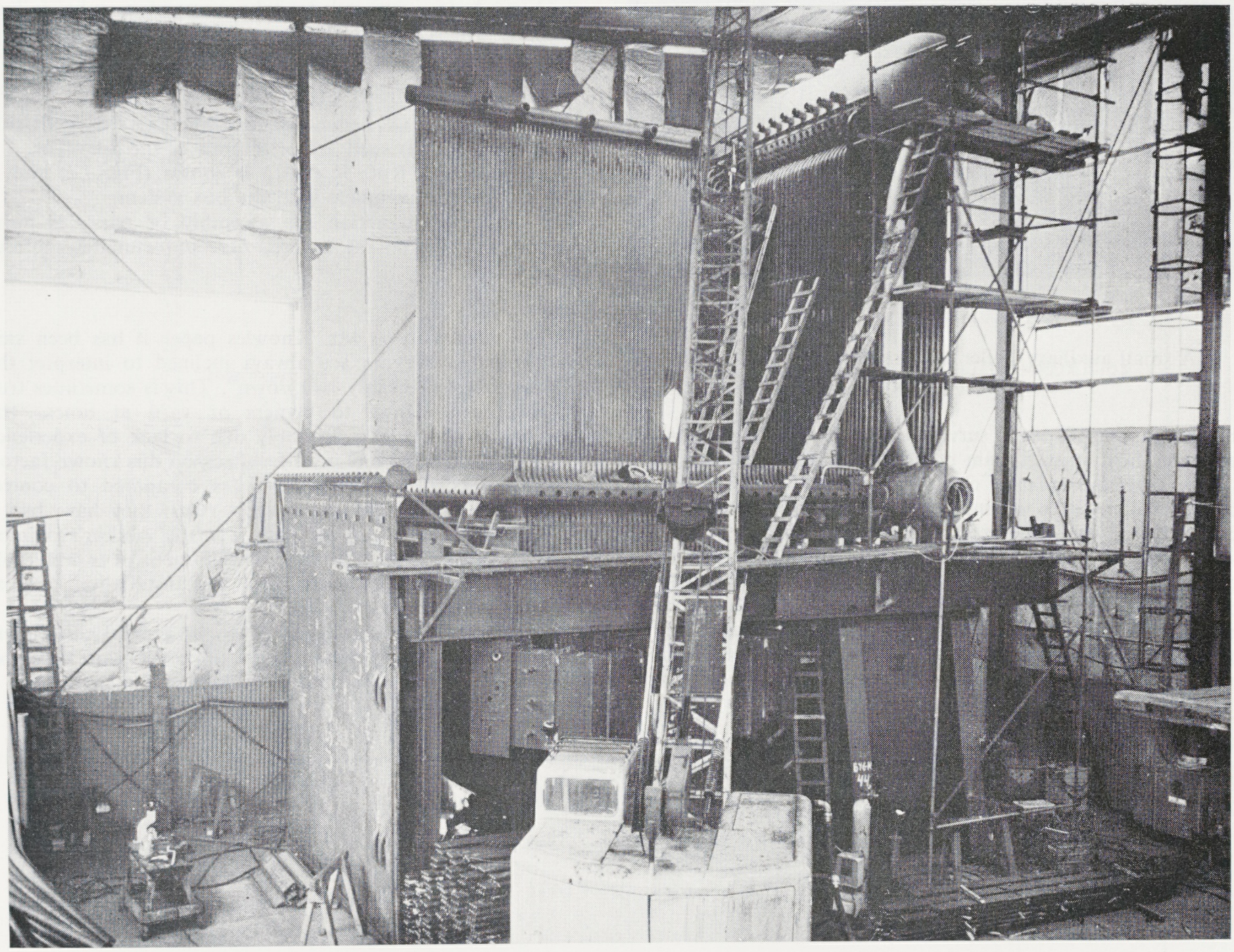


PLATE 7.2

Tangentially fired main boiler under construction at the shipyard.

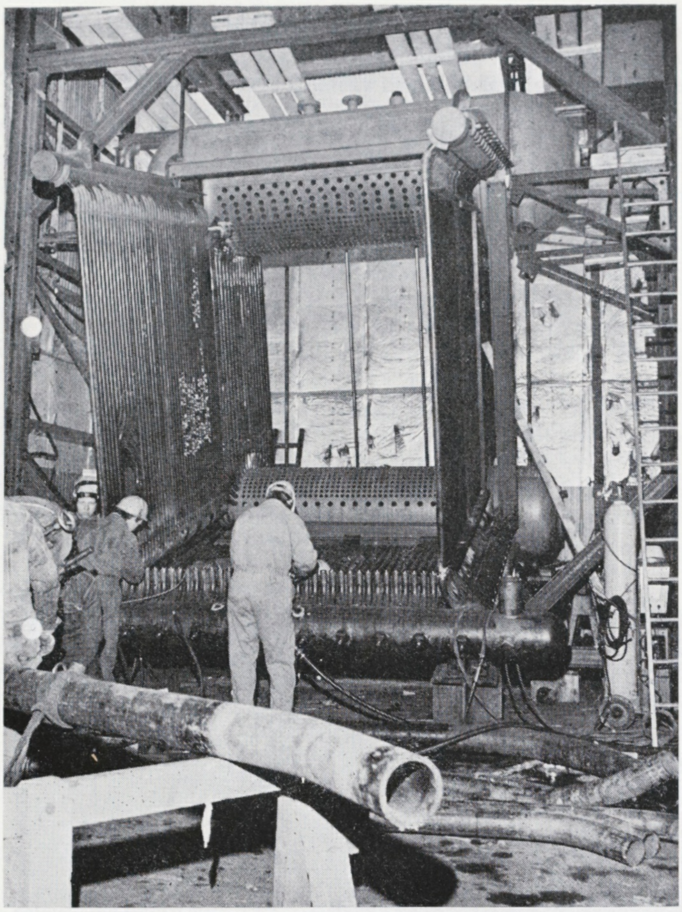


PLATE 7.3

A small auxiliary boiler as partner to the main boiler of Plate 7.2

being constructed under survey, although we are required to examine them at each main boiler survey to C 1002.

The biggest headache concerning on-site construction of one-off boilers, is to accumulate the paper work necessary to cover the survey. The certificates required (Q 705) take quite some time to obtain from small sub-contractors and it is for this reason we are pleased when a completed and documented boiler comes from colleagues further up country. The requirements of J 402–J 427 amongst other things should be adhered to with special reference to X-rays on pipes butts over 170 mm outside diameter to be 100 per cent radiographed. Below this size there is to be radiographed 10 per cent minimum, dependent on the reliability of the welder. The radiography is normally carried out by a National Authority and checked by the Surveyors later. The marking of each weld should be good (J 421) and I.Q.I.'s well placed (J 422). At times a wooden box enclosing two fluorescent tubes is the offering we get to view the films, but the control department of the yard should be talked into obtaining a good air-cooled viewer with a dimmer and foot switch (J 423).

One or two companies have discussed the use of gas draw-off to partially load the boilers. In this instance one would imagine that R(A)117 will have to be studied a little more closely. Inspection after sea trials will be dealt with under that heading.

Steam to Steam Generator

All items applicable to the boilers concerning chocking, safety valves and shut-downs are, likewise, to be used here. The steam or feed lines of these 14,5 kp/cm^2 generators are usually thicker than others (J 512) and a check with the drawing office concerning this is worthwhile. The heating coil saftey valve (J 610) should be tested although the drum valves may have been increased to take care of a tube failure internally. The steam/steam generator as such is a Class 1 pressure vessel if over 11,5 kp/cm^2 (J 107).

Of Special Interest to the Surveyor

In this instance all items have been enumerated with rule requirements and as such are of interest to the Surveyor.

The F.E. Form Rpt. 5c (Inst.) is shown (Fig. 7.2) and is extremely easy to complete with the box system.

For on-site construction the assembly of paper is more extensive and will not be covered here unfortunately, due to lack of space.

Comment

In the discussion to Mr. Knowles paper it has been said that "Young Surveyors are always inclined to interpret the Rules as they are strictly laid down". This is sometimes true and can be upsetting to owners or yard at times. The adherency to the rule is probably due to lack of experience in the early stages, so one must fall back on this known factor. However, concerning boiler rules (as compared to control engineering or electrical a.c. systems rules) they have had a long time to solidify and as such it is the Author's opinion that it does not matter how experienced one is, it is preferable to interpret the boiler construction and installation rules as closely as possible.

Although the mini age is upon us, in general the boilers are becoming larger as materials are improved with time and more vicious if the contents are let loose.

Rpt. 5c (Inst)
Received London

Report on **INSTALLATION OF WATERTUBE BOILER** – MAIN.
FOR CONSIDERATION BY THE COMMITTEE OF LLOYD'S REGISTER OF SHIPPING

NOTE:—The particulars in this report are to be stated as fully and as clearly as practicable. Where the answer is "NO" or "NONE", say so. Ticks and other signs of doubtful meaning are not to be used. Wording not applicable to be cancelled. Where items are marked with an asterisk* the particulars need not be repeated here if they are given on the relevant Rpt. 5c(Cons).

Ship's name – – – – – –

Port – – – – – –

Rpt. 5c(Cons) No. – – – – – – –

Rpt. No. 1

Date of completing Report: SEPT 73

Attached to (*Port*) – – – – – – – –

Place of survey, if different from above – – – – – –

Number of visits on ship: 10

First date: JULY 73

Last date: SEPT 73

Ship built by – – – – – – – – –

Yard No. – – –

Boiler installed by – – – – – – – – – –

Year: 73 Month: SEPT

*Main, auxiliary or domestic (*See key to R.B.*): 5c(CONS) 42/12

Forced and/~~or induced~~ draught: 2 MAIN

*Number of boilers: "

Type of air heater: ROTARY

***Heating Surface, each Boiler**

Water tubes (including waterwalls): "

Fuel (or source of heat): BUNKER . C

Superheater tubes: "

Is boiler front or top fired? TOP

Economiser tubes (half only): "

Number of burners, each boiler: 4

Total: "

Name of oil-burning system – – – – – – – – – –

*Designed evaporation, each boiler, at max. continuous service rating: "

*Approved temperature of steam at superheater outlet: "

Name of combustion control system, if fitted – – – – – – – – – –

*Nominal composition of material for principal boiler mountings for

Saturated steam: "

Number and type of water-level indicators fitted to each boiler: 3 W.L. INDICATORS
3 GLASSES STAGGERED
1 BI – COLOUR
1 AUTO REMOTE

Superheated steam: "

Type of feed-water regulators fitted to each boiler – – – – – – –

***Desuperheater** Port †Cert. No. "

How is temperature of superheated steam controlled? ATTEMPORATOR

***Economiser** Port †Cert. No. "

Are drain cocks or valves fitted to free superheater from water, where necessary? YES

***Attemperator** Port †Cert. No. "

Are drain cocks or valves fitted to principal boiler mountings for steam? YES

***Reheat unit** Port †Cert. No. "

Least distance between boilers, uptakes or heated air trunking and O.F. tanks (incl. D.B.): 2 METRES

Has the spare gear required by the Rules been supplied? YES

Date of Committee

Minute

†*Copy to be forwarded*

(MADE AND PRINTED IN ENGLAND)

FIG. 7.2

BOILERS

Fill in a boiler section for each type of Boiler/Steam Generator/E.G. Economiser/Thermal Oil Heater fitted. Check one Type box, one Description box, and all Options fitted (state number if more than one of any option fitted.)

1.

Class / Number		Type		Description		Options	
(Give number of identical boilers of one class only)		W.T. boiler	1	O.F. package boiler	N/A	Air heater (incl. rotary)	1
Main	1	Smoketube boiler	N/A	O.F. Press boiler	N/A	Superheater	1
Aux.	N/A	Steam generator	N/A	Oil fired	1	Desuperheater	1
Domestic	N/A	Dual pressure W.T.B.	N/A	Exhaust Gas fired	N/A	Attemperator	1
Ex. G.E.	N/A	Economiser	N/A	Composite	N/A	Main economiser	1
Stm/Stm Gen.	N/A	Reheat	N/A			Fired boiler circ. pumps	N/A
Thermal Oil Heater	N/A					Boiler ~~front~~ top oil burning unit	1
						Steam receiver	N/A

Where more than one of a type is fitted, state relative positions (One) Main 4th deck (centre)

2.

Class / Number		Type		Description		Options	
(Give number of identical boilers of one class only)		W.T. boiler	1	O.F. package boiler	N/A	Air heater (incl. rotary)	N/A
Main	N/A	Smoketube boiler	N/A	O.F. Press boiler	N/A	Superheater	1
Aux.	1	Steam generator	N/A	Oil fired	1	Desuperheater	N/A
Domestic	N/A	Dual pressure W.T.B.	N/A	Exhaust Gas fired	N/A	Attemperator	N/A
Ex. G.E.	N/A	Economiser	N/A	Composite	N/A	Main economiser	N/A
Stm/Stm Gen.	N/A	Reheat	N/A			Fired boiler circ. pumps	N/A
Thermal Oil Heater	N/A					Boiler ~~front~~ top oil burning unit	1
						Steam receiver	N/A

Where more than one of a type is fitted, state relative positions (One) Auxiliary 4th deck (p)

3.

Class / Number		Type		Description		Options	
(Give number of identical boilers of one class only)		W.T. boiler	N/A	O.F. package boiler	N/A	Air heater (incl. rotary)	N/A
Main	N/A	Smoketube boiler	N/A	O.F. Press boiler	N/A	Superheater	N/A
Aux.	N/A	Steam generator	1	Oil fired	N/A	Desuperheater	N/A
Domestic	N/A	Dual pressure W.T.B.	N/A	Exhaust Gas fired	N/A	Attemperator	N/A
Ex. G.E.	N/A	Economiser	N/A	Composite	N/A	Main economiser	N/A
Stm/Stm Gen.	1	Reheat	N/A			Fired boiler circ. pumps	N/A
Thermal Oil Heater	N/A					Boiler front oil burning unit	N/A
						Steam receiver	1

Where more than one of a type is fitted, state relative positions One only St/St Generator 4th dk (s)

How is steam raised (initial start) Diesel Oil Ignition

Is steam used for essential services yes — Material of main steam pipes 13 Cr Mo.44

Are aux. steam pipes over 3″ bore yes — Material of aux. steam pipes SM Steel

FIG. 7.3

Rpt. 5 SGE (Inst)
Received London

Report on INSTALLATION OF STEAM HEATED STEAM GENERATOR
~~EXHAUST GAS HEATED BOILER or EXHAUST GAS HEATED ECONOMISER~~

(*For use with Cert. SG or Cert. E*)
FOR CONSIDERATION BY THE COMMITTEE OF LLOYD'S REGISTER OF SHIPPING

Ship's Name .... Port ......

Cert. SG/E No. .... Rpt. No. 1 Date of completing Report SEPT 73

Attached to (*Port*) .... Place of survey, if different from above ......

Number of visits on ship 5 First date JULY 73 Last date SEPT 73 Year Month

Ship built by .... Yard No. 100

Component installed by ....

~~Steam generator, exhaust gas boiler or exhaust gas economiser~~ STEAM GEN. For boilers only: auxiliary or domestic (*See key to R.B.*)

SAFETY VALVES

*Makers	CONS. CERT No.....
*Type	"
*Number and diameter — As approved	"
*Number and diameter — As fitted	"
Material of chest, nominal composition	S.M STEEL
Are safety valves fitted with easing gear?	YES
Are drains fitted to all safety valve chests?	YES
Are safety valves of each exhaust gas heated economiser and each exhaust gas heated boiler which may be used as an economiser provided with entirely separate waste steam pipes and drains?	—
Are drains fitted to principal boiler mountings for steam?	YES
Number and type of water level indicators, each boiler	3: ONE GLASS – ONE AUTO SHUT DOWN ONE LEVEL TRANSMITTER
Smallest distance between boiler or exhaust piping and nearby oil bunkers or woodwork	2 METRES

DECLARATION TO BE SIGNED BY INSTALLING ENGINEERS

To the best of our knowledge the component has been installed in conformity with the Rules, Regulations and requirements of Lloyd's Register of Shipping, and the foregoing particulars of installation are correct.

Signature.................... Date..........

A previous similar case was for (*name or contract No.*)

Port Rpt. No.

DECLARATION TO BE COMPLETED AND SIGNED BY SURVEYOR AT PORT OF INSTALLATION

The STM – STM GEN described in (*Port*) ....

Cert. SG/E No. .... has been securely fitted in the ~~MV~~/SS ....
in accordance with the Rules under my inspection and to my satisfaction, examined under working conditions, and the safety valves adjusted to 14·5 KP/CM² . ~~A satisfactory accumulation test was carried out~~. The spare gear required by the Rules has been supplied. The STM – STM GEN installation is eligible, in my opinion, for the notation ONE STM – STM GEN 9-73

....
Surveyor to Lloyd's Register of Shipping

Date of Committee

Minute

NOTE:—The particulars in this report are to be stated as fully and as clearly as practicable. Where the answer is "NO" or "NONE", say so. Ticks and other signs of doubtful meaning are not to be used. Wording not applicable to be cancelled. Where items are marked with an asterisk* the particulars need not be repeated here if they are given on the relevant Cert. SG or Cert. E.

(MADE AND PRINTED IN ENGLAND)

FIG. 7.4

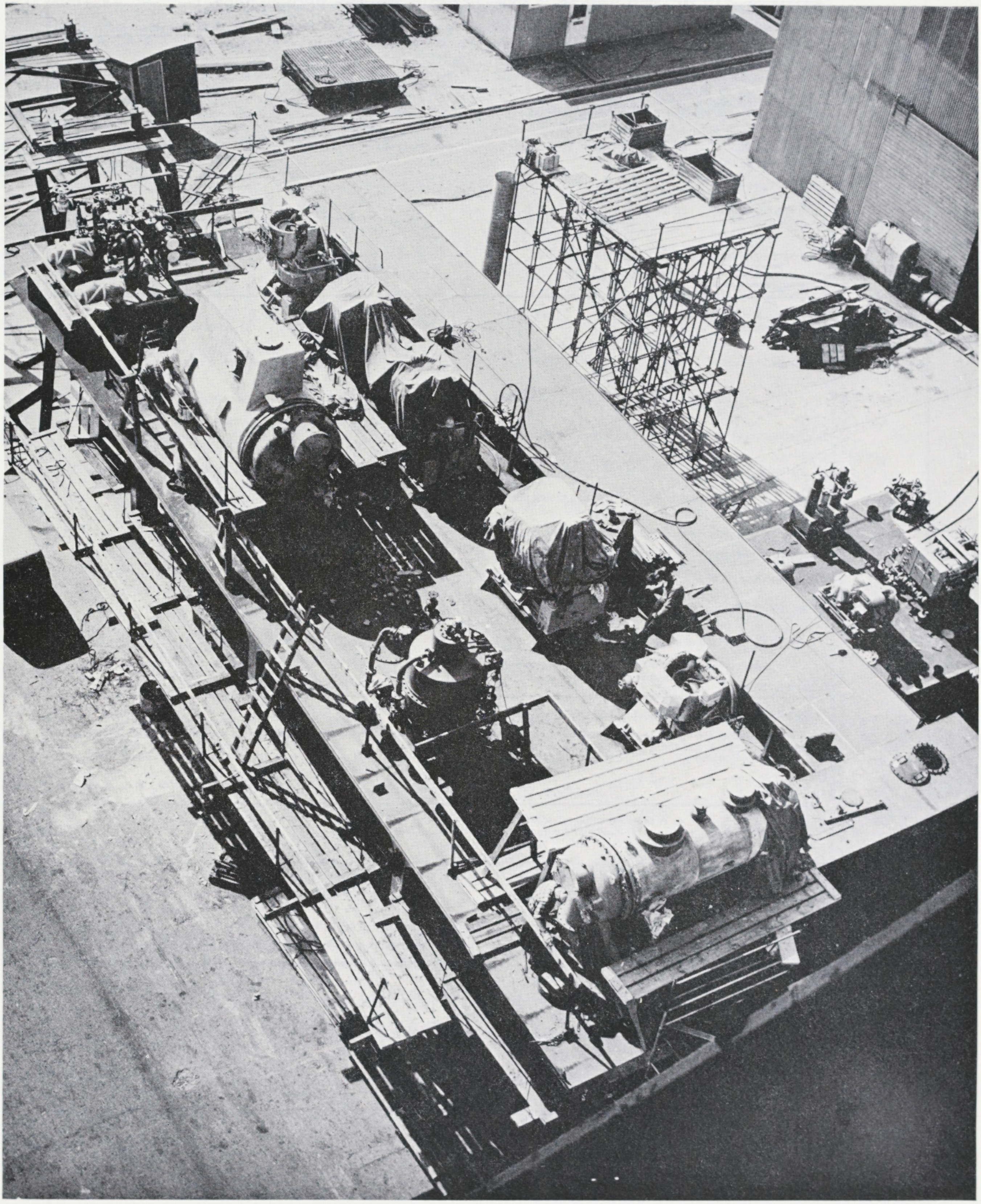


Plate 8.1

8. Pumps and Ancillaries

Tremendous strides have been taken in the assembling of machinery systems since the days of on-board *in situ* mounting of pumps and other ancillaries. By this statement it is meant that a complete deck of machinery level is now prefabricated in the workshop, then moved onto its pillars in the machinery space and "zip-weld" completed. Such a complete level can be seen in Plate 8.1. At the top left hand side is the dual pumps of the oil fuel units. Next to this is situated the auxiliary condenser with a tradesman applying the insulation. Further down comes an oily-water separator and then a welder working on the atmospheric drain condenser. The back row consists of four cargo pump turbines and one ballast turbine. On the smaller platform alongside one can see control air compressors, driers and filters. This particular photograph shows the deck out of doors, but this is only due to it being completed and ready to land on the machinery space.

What problems now face a Surveyor under these conditions? If the chocks and alignment are checked here will they be the same after plaform distortion due to lifting and welding in place? In general it has been found that most vertical pumps have extremely flexible intermediate castings between the impeller casing and electric motor. This in-built flexibility with small area of deck to which they are bolted make them suitable for accepting abuse. However, it is well to carry out spot checks when the pumps have finally come to rest within the framework of the aft end structure. The objects that do not withstand this treatment too well are longbase items and horizontal pumps attached to electric motors. The couplings should be disconnected and checked with a clock gauge in each instance, or arrangements made with production not to see these until they are on board. Plate 8.2 gives an impression of the conditions under which one is expected to carry out surveys these days. With snow on the ground and a force five wind blowing, one is not too enthusiastic about lingering over a chocking and alignment set-up.

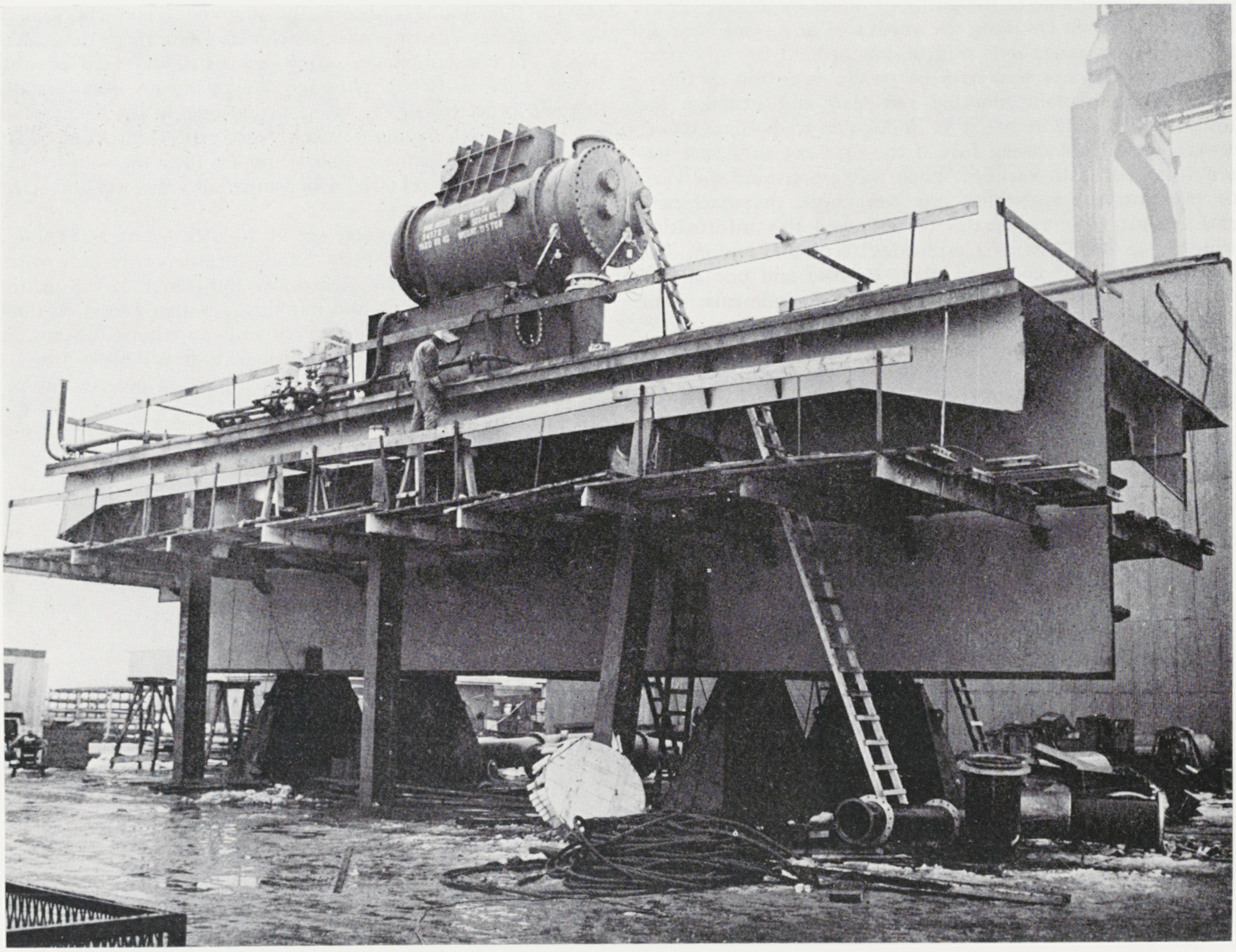


PLATE 8.2

Long-base pumps are also susceptible to "forced alignment" as shown in Fig. 8.1.

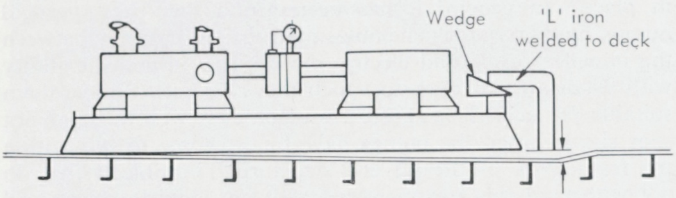


FIG. 8.1

In the above diagram the pump has been chocked and aligned within 0,05 mm on its rigid foundation in the workshop. If the decking is then found to be out of line, three things can happen: (i) the welder can call the attention of an engineer to this fault, (ii) several electrodes can be wedged under the horizontal plate and seal-welded out of sight, (iii) an angle-iron and wedge can be used to obtain face to face contact before welding. It is always best to ask for the coupling to be split for checking at a later date as many shaft breakages attributable to design faults could be initiated from such causes. When checking the chocks of any items with an 0,05 mm feeler gauge it is well to cast around for any loose plastic drinking cups that may be on the tank top or thereabouts which contain marking red lead and examine the substance. After 12 hours it is impossible to push anything between chock and casing face if the marking substance has been "thinned" with varnish. When walking around the various platform sub-assemblies one can check the machinery items against their certificates (G 103) and this information included in the "List of Certificates" sent to London. The layouts must be to approved plans (G 104) and one should check with the drawing office concerning amendments. Prior to dealing with newbuildings the Author was at times a perpetrator of the loose practice of stamping a batch of 20 or more items and departing from the factory before all the information, as stated on the certificate, had been laboriously stamped on the pump casings. However, now being a victim of this practice, many frustrating hours are spent scraping off the paint from items in the hope of eventually finding the markings. At times the makers-plate information must suffice. It would appear that there is no standard place to put stampings. The best solution and most helpful to a newbuilding colleague is to emulate colleagues in Germany or Austria. Each item from these countries are stamped to infinity and beautifully documented. This must involve many hours work but is a tremendous help concerning on-site identification.

Many auxiliary engine air receivers are hung by crutch arrangements onto a bulkhead. Stiffeners which have been welded on the reverse side of this bulkhead can be observed by the discolouration of plating along the weld run. Should there not be any such tell-tale markings in the area of items such as air receivers, one should bring it to the attention of hull colleagues as the item concerned will vibrate as though fastened to the centre of a drum skin. If the engine room has CO_2 fire smothering, the air receiver fusible plug should be piped to deck (J 640). Air compressor safety valves, if sealing is not evident, can be tested and drains proved clear (J 641) and then the non-return valve as required by H 612 located in the starting air system. (Many times it is overlooked.)

With the auxiliary diesels the alignment and chocking is very much as for the other machinery. The most time spent should be concerning the safety devices of overload possibly 10 per cent as H 107, although the certificate usually states this and other tests have been carried out. In the event of an auxiliary diesel having a "first start" diesel-air compressor coming into the same exhaust uptake, then they must have an isolating valve (H 604), which invariably distorts and seizes up.

The overspeed governor, set at 10–5 per cent as H 606 is reasonably easy to test by hand, together with any other safety devices of H 616. Remember the advice of the section on Control Engineering and minimise simulated tests on these items. The steam turbine for driving an alternator has, in addition to the above safety devices, a steam back pressure trip, loss of oil feed and overspeed up to 15 per cent as per H 828.

STOP and MANŒUVRING VALVES (Turbine Installations)

Give details of valves fitted (i.e. emergency bulkhead stops, ahead and astern manœuvring and astern guard valves)

O.F. TANKS *(Include all O.F. tanks not forming part of shell, watertight bulkheads or strength decks)*

Service	Position	Capacity

STEAM and OIL ENGINE AUXILIARIES

N.B.—*Details of small engines other than for generator drive are not required, but indicate '& engine' after driven unit in relevant section of the report.*

Maker and Type (reciprocating)	Steam, 2 or 4SC	In line or V bank	No. of Cyls.	No. of Main Journals & Bearings	How Started (oil engines)	Position of Engine	All Driven Machinery (for generators state kW rating)

TURBO-GENERATORS and GEARING

Maker	*Indicate integral ancillaries driven by or part of unit below with an X*						Position of Engine	All Driven Machinery (for generators state kW rating)
	Con-denser	S.W. circ. Pump	Extraction Pump	L.O. Pump	L.O. cooler			

PROPELLERS

Number of propellers fitted each shaft line ☐

Is propeller: solid ☐ controllable pitch ☐ directional ☐

Athwartship Thrust

If an athwartship thrust unit fitted, state number against type, and position in ship:
C.P. propeller ☐ Fwd ☐
Solid propeller ☐ Amid-ships ☐
Jet ☐ Aft ☐

Prime mover ....

SCREWSHAFT ☐ and/or TUBESHAFT ☐

Is a continuous liner fitted Yes ☐ No ☐

Is material of shaft corrosion resistant Yes ☐ No ☐

If 'yes', state material ....

Is an approved oil gland fitted Yes ☐ No ☐

Is propeller: fitted on a cone ☐ / bolted to a coupling ☐

Fig. 8.2

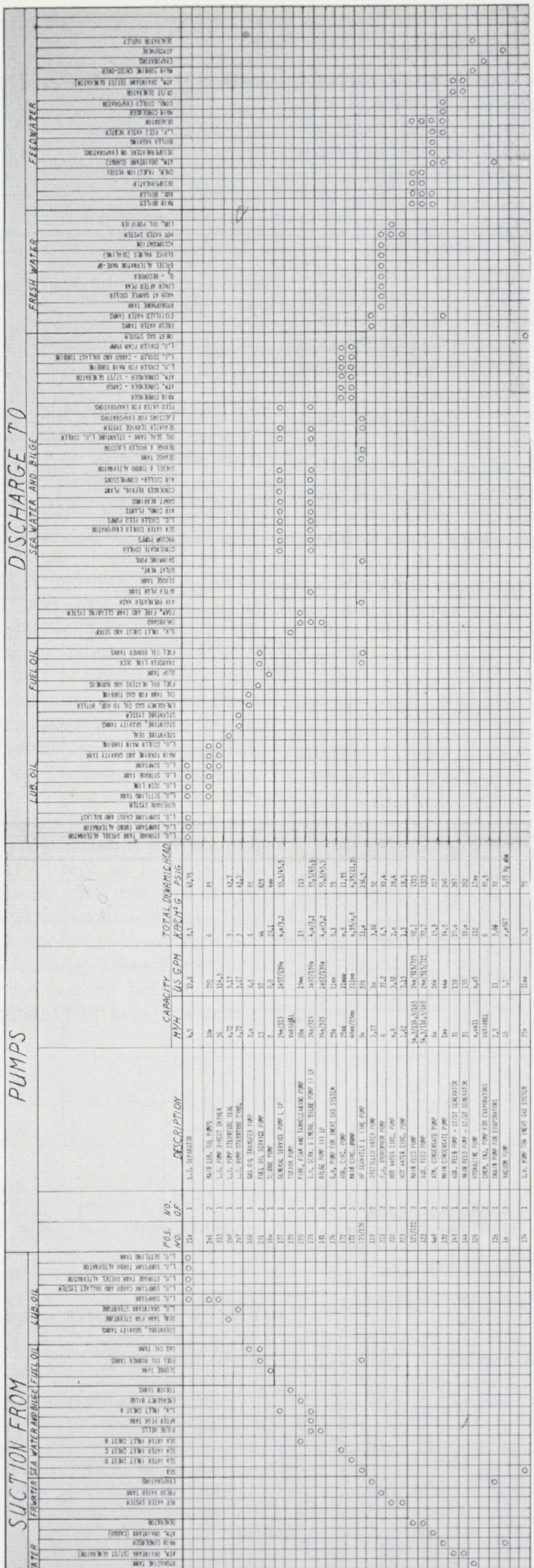


FIG. 9.1

9. Pipework Installations

This subject of systems involves the Surveyor in more working hours than most other surveying tasks connected with new construction. Many people comment that they find it difficult to analyse or interpret the rule requirements, instructions and circulars in relation to newbuildings. However, it must be remembered that although one need not be a walking rule book, the latter items are the topical tools of our trade as Surveyors and some reasonable effort must be made to become fully conversant with their contents. There can be several reasons for being at times frustrated, by what can appear to be an insurmountable wall of requirements and recommendations both National and International. Maybe it is because working on one's own without encouragement or help with additional explanation that the going gets tough. One can come to a point where it isn't understood what, at times, appears to be conflicting requirements. In a large office with colleagues that have extensive newbuilding knowledge this need not happen. In smaller offices, where the collective knowledge that is prepared to be pooled can be limited, it becomes a case of the blind leading the blind. It is then that the Instructions to Surveyors and Technical Association Papers are lifesavers and a tremendous help and none more so than those written on the subject of Pumping and Piping (Ref. 5).

Due to the vastness of Chapter E with associated information distributed throughout other chapters, one can never expect to understand the contents at the first or second reading. This is not because of stupidity or senility but simply because the subject is new and one has to find its groove. One must take the contents bit by bit and when lost go back again and maybe write down the relevant section on a scrap of paper. Any colleague that has tried explaining the requirements of an R.M.C.–(R.S.) and R.M.C.–(S.S.) (*see* Ref. 6) survey to a ship's captain will understand what is meant. It is better to do one thing at a time and understand it before going on, and learn one thing too much than two things not enough. This may appear to be sermonising but unfortunately it is a fact of newbuilding life and to define one's terms of reference is virtually impossible.

It is only intended to run through a very condensed version of the main points of examination in each major system. Comments on a few items that tend to initiate discussion between Surveyor and shipyard will be included but not diagnosed.

When checking systems it is well to ensure that plans according to the requirements of E 101 are available. Weekly visits to the drawing offices for the specific task of updating plans by inclusion of amendments is a practice worth initiating.

(a) Sea water

The material that heads the present popularity poll for sea water pipe systems is a mixture of aluminium and brass or bronze. This material may have overcome the water velocity problems (R(D) 113) that were associated with copper piping in high pressure systems but tends to aggravate and accelerate galvanic corrosion in areas traditionally susceptible to this action. Tankers normally spend most of their time under seagoing conditions of 85–100 per cent full power and as such all systems are designed to give a balanced optimum performance within these limits. In the sea water system this flow control is achieved by incorporating orifice plates in the lines (R(D) 114). With these fixed size orifice plates, in any condition other than that of seagoing, there appears to be arising problems of flow (R(D) 113), turbulence and corrosion. The life of main engine lubricating oil cooler tubes has diminished considerably and been attributable partly to this condition. The traditional materials that were regarded as being suitable for sea water due to their corrosion resistant properties are now coming under scrutiny and have been found to be wanting. Stainless steel depends on a thin oxide skin formed by the melt additives to protect it against corrosion. It has been suggested that any grade of stainless below EN 57 (BS 970) should not be classed as a sea water resistant material. When this material is used raw, in new valves and pumps in stagnant waters such as outfitting quays, the lack of oxygen prevents the forming of an oxide skin. Corrosion or heavy pitting then occurs since the material could as well resemble mild steel without its protective oxide skin. When the ship finally sails in normal sea water so begins inter-crystalline crevice corrosion. Table R(D) 1.1 shows this metal to be less noble than the pipe system of aluminium bronze and will then be sacrificial and so another point is lost in its favour. It would now appear that one must be careful to keep a constant flow of clean sea water passing through pumps, condensers, coolers or valves using a stainless steel and flush out these items if they have been used for harbour duties under contaminated water conditions.

The aluminium bronze pipes have an oxide skin property created by the aluminium content. The fact that it does not suffer harbour corrosion is attributable to the bronze factor. The table R(D) 1.1 mentioned earlier shows that monel is more noble than stainless and should give a longer in-service life. There are stainless melts being developed called 25 per cent chrome steel which are supposed to have less risk of crevice corrosion and resist the ever increasing pollution ingredients of sea water. However, these appear to be overpriced, difficult to flow correctly into a casing mould and generally not available. Plates 9.1 and 9.2 show taper pins from the type of butterfly valve shown in Plate 9.3. The immense size of modern valves is quite staggering and one can imagine the problems that arise when the pins shown must be changed due to corrosion after one month in service. The positioning of two such taper pins can be seen at the upper and lower

Plate 9.1

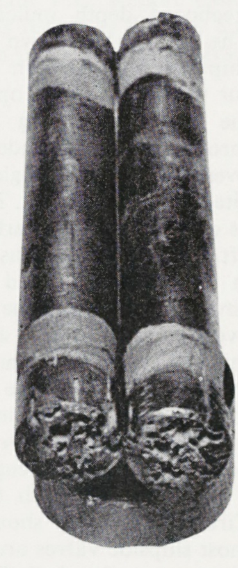


Plate 9.2

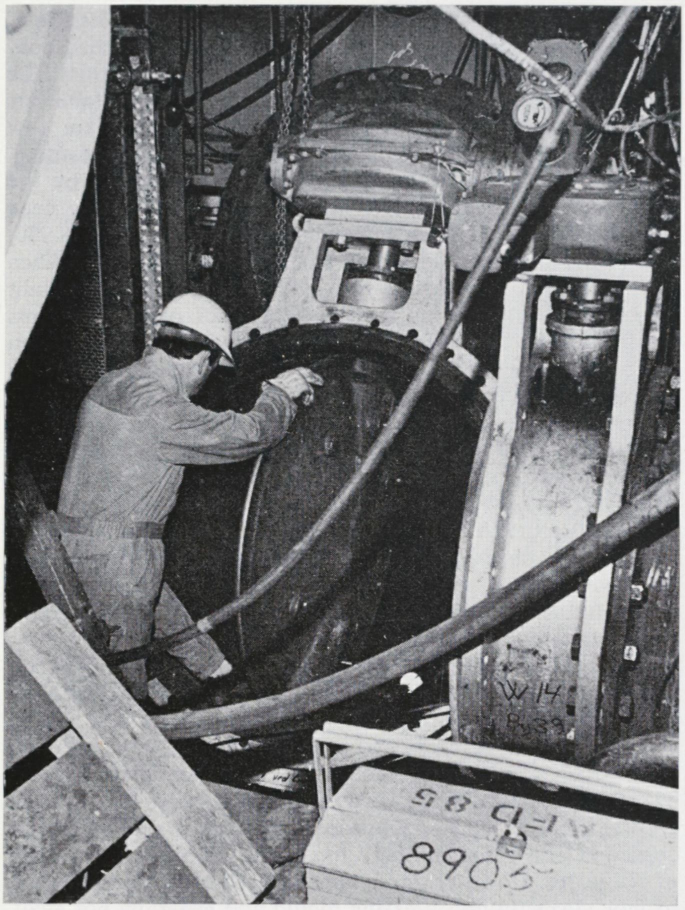


PLATE 9.3

extremities of the valve in Plate 9.3. Shipside valves are to be of bronze, steel (D 2818), or other approved material (E 270) (possible S.G. iron, but it is not recommended personally). This would include such items as speed logs, forward and aft freeboard depth indicator transducers, and echo sounders. The large valve shown is part of the scoop system. When the ship reaches a certain speed, a water pressure device signals for this valve to be opened automatically by hydraulics and the main circulating pump to cut-out. The water flows through the main condenser and main lub-oil coolers and then overboard at right angles to the ship's centre line on the opposite side to the suction. The direction of the outlet is emphasized as on some earlier Mark I models the water exit faced directly aft. When the ship was moving astern this outlet scoop acted in reverse and backed up against the pressure of the main circulating pump. Due to lack of flow the main condenser overheated and many strange, frightening things happened. As this inlet valve and pipe is fixed to the ship's structure and the main condenser is free to move on its springs, there must be a flexible connection incorporated in the lines. This must be protected (E255) to prevent ingress of large quantities of unwanted water to the engine room.

When dealing with butterfly valves for shipside purposes, Circular No. 2257 should be discussed with the yard. Today most shipside valves are connected by short rigid and stiffened distances to the shell (E 267). Fig. 9.2 shows an edge preparation and welding at the shell. The distance pieces are extremely

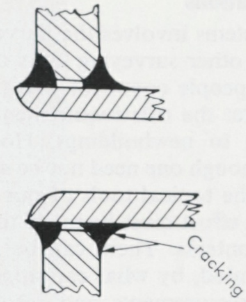


FIG. 9.2

prone to weld cracking on the inboard side. Especially if the included angle between pipe and shell plate is less than 90°. This is due, possibly, to the welder using the inner run as a lining up tack, or light seal run and then carrying out a heavy deposit bead on the outside. Whatever the reason these should all be very carefully dye-penetrant checked before the painters have a chance to hide any defects with particular reference to the suctions, before the ship is floated.

When strolling around the ship's bottom prior to the dock being flooded one can check if the gratings (E 267) have been fitted with stainless steel bolts and nuts. At this outside examination it can be seen if the openings through the shell have been cut clean or edges ground smooth (D 514). This may sound like duplication of hull colleagues' work, but with the vast areas of steel they must examine on a V.L.C.C. it is possible such small details can be overlooked and if one is in the area why be oil and water conscious. It is better to duplicate than overlook. This goes for internal examinations concerning overboard discharge from scuppers or sanitary lines. These should be covered by a S.D.N.R. valve as in D 2814 with indicators, etc., and any deviation should be brought to a hull colleague's notice. If time permits examinations of many diverse items including those of hull structure, then one's own designated portion becomes so much easier to examine and in sharper focus.

To revert to the piping system. The various pipe lengths should be examined dry after brazing and pipe bores verified as being smooth and clean at weld junctions (R(D) 114). If the pipe length has many bends incorporating brazed elbows rather than bending machine changes in direction it should be discussed if the pipe run cannot be modified. A few rejections of poor workmanship in general produces better piping systems. Recently tests have been made locally on aluminium bronze piping using a filler (R(D) 109), against pure melt fusion. Destructive vibration tests show the latter to be as strong and flexible as the former. The omission of the filler rod also makes for a smoother internal weld, but this is only in the experimental stage at the moment. After internal examination and acceptance the lines are tested hydraulically in the shop (E 503) for the purpose of finding weld porosity.

The incorporating of plastic pipes is finding increasing favour for items not subject to heat or too much pressure such as sanitary, toxion and fresh water. This finds acceptance in R(B) 105, but should not be used for fire-bilge, main and auxiliary sea water, feed, condensate or oil lines (R(B) 106).

(b) **Bilge**

Amongst the pieces of string, chalk and other paraphernalia in a Surveyor's boilersuit pocket there is usually a steel tape. With this handy instrument can be checked the sizes of the various bilge well and hatbox capacities (E 207). A discussion with hull colleagues about bilge systems with reference to any hidden strums that require to be isolated by special access manholes, as may occur in the steering gear space, or underneath machinery in void spaces is time well spent. The steering gear compartment mentioned is normally above an aft peak tank and as such requires a hand or portable powered bilge pump (E 210). This information is incorporated on the S.E.1 certificate. Bilge high level alarms (E 217) should be checked by filling the well with water rather than lifting the float by hand. These alarms usually sound-off in the control room, engine room accommodation (L 207), and sometimes on the bridge. A test of the various pumps designated bilge or general service should show that they are self-priming and capable of pumping a known quantity of water at the rate of 122 m/min or more (E 235).

The tail pipes from mudboxes should be free of bends (E 248) although the straight pipe can lay at an angle to allow it to reach the bottom of the bilge well as depicted in Figs. 9.3(a) and 9.3(b) showing the aft bilge well with S.D.N.R. valve (E 246) incorporated in the line, situated under the propeller shaft.

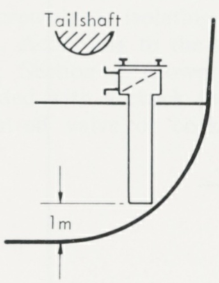


FIG. 9.3(a)

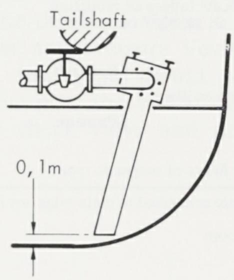


FIG. 9.3(b)

The problem of accessibility arises (E 251). The question "What is accessible?" is often asked and is very much to the personal interpretation of the Surveyor, except for main and bilge injections, which are stated to have handwheels not less than 460 mm above the lower platform (E 269). Fig. 9.4 shows how deep down an engineer must crawl before the ability to clean the mudbox at position A is possible. Often there are large quantities of loose water surging around the tank top as an added hindrance. Relocation of this item to position B can then cause suction height problems.

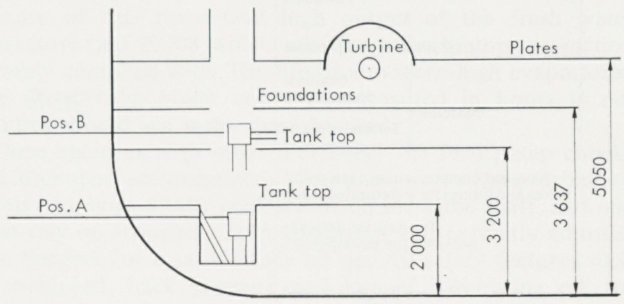


FIG. 9.4

The perforated filter boxes at the base of suction pipes should only be in spaces other than machinery spaces (E 250). The pump room with its stripping, cargo and ballast pumps may well be argued as a machinery space (E 224). Likewise the fore peak (E 113) with its diesel and emergency fire-foam pump. At this time the chain lockers and peak valves extended spindles can be operated and verification that the valve is not attached to the collision bulkhead can be ascertained (E 262 and E 263).

The bilge lines are initially hydraulically tested in the workshops, and at this time the workmanship and brazing of the non-ferrous lines can be examined (E 503). The actual bilge suction tests ought to be carried out as late as possible prior to casting off the ropes for sea trials. The tank tops and wells should be reasonably free of construction debris by then.

In conclusion, the Yard Drawing Office should be encouraged to formulate a schedule showing the suction and discharge points of each pump as shown in the micro-photograph Fig. 9.1. This makes the revelant F.E. Report easier to compile and can be attached to this report as the size and space is no longer adequate for modern piping system analysis.

MAIN STEAM TURBINES ONLY

If single screw ship, can steam be led direct to I.P. or L.P. turbine?	If reheat arrangements are fitted, give details
Can either H.P. or I.P. turbine exhaust direct to condenser?	

STEAM PIPES	MAIN	AUXILIARY (over 3" bore for essential services)
External diameter		
Thickness		
Hydraulic test pressure		
Material: Nominal composition	SEE ATTACHED DETAIL SHEET	
Material: Tensile strength approved		
Nominal composition of material of valves and fittings for superheated steam		
Is adequate drainage provided for steampiping?		
How are flanges attached		
State if butt welded or special (*e.g.* CORWELL) joints employed		

FEED SYSTEM

Are all boilers provided with two separate means of feed?	Number of Duplex suction filters
	Main condenser tube material, nominal composition

LUBRICATION

Can normal supply be maintained with any one pump out of action?	Is an alarm device fitted to indicate failure or reduction of supply from pumps?
Is an emergency supply available as per Rule? (*turbines only*)	Number of Duplex filters: Suction / Pressure
Over-pressure relief arrangements	
	Are filters of magnetic type?

BILGE SUCTIONS Number and size in each hold, deeptank, cofferdam and pumproom	Number and size connected to main bilge line in:—
	Main engine room
	Auxiliary engine room
	Boiler room
Size and position of direct suctions in machinery spaces	Tunnel
Size and position of emergency suctions in machinery spaces	Has the bilge and ballast system means for separating oily water on the overboard discharge side?
	Are traps fitted to drains from boiler room or oil tank flats to bilges?

Do the pumping arrangements comply with the Rules, including special requirements for oil tankers, ships classed for carrying cargo oil, or classed for navigation in ice Class 1*, 1, 2 or 3?†

If ship is to be classed for navigation in ice, state means provided for clearing ice from ship's side valves

Delete words not applicable

FIG. 9.5

(c) **Boiler Feed**

The feedwater system invariably has the highest line-pressure of any system on board. The small hydraulic lines to valve actuators are a possible exception. Most other system lines are hydraulically tested in the workshops and then fully assembled by bolted flanges on board the ship at a later date. Any leakages encountered will then be gasket leaks and relatively easy to repair, rather than weld porosity seepages which can be very troublesome. The feedwater system does not come into this category of shop testing, but is welded, X-rayed and hydraulically tested in place to twice the design pressure (J 523(h)) or twice the maximum pressure which can be developed in the feed line in normal service (feed relief valve setting is the maximum pressure (J 639)). Although the feed line butt-welds are 100 per cent X-rayed and defects repaired, it is still possible to come across weld porosity during the hydraulic testing programme therefore the examination should be very thorough.

There are normally two feed checks (J 636), being main and auxiliary. Plans vary and sometimes show a non-return valve on the boiler shell with a screw-down valve between this and the pump, this being double check valves on each line, or alternatively with the screw-down valve attached directly to the boiler shell. When the former is the case, trouble can occur if this non-return valve seizes or jams due to build-up of boiler treatment chemicals or inclusion of extraneous foreign particles. To clear the fault requires the boiler to be shut down as the screw-down isolating valve is on the dead side from the drum. According to the A.S.M.E. Boiler and Pressure Vessel Code, Section 1 (Power Boilers) the feed pipe should be provided with a check (non-return) valve near the boiler and a shut-off valve or cock between the check valve and the boiler.

In these modern times of complex automated equipment one would not expect to see a geared rod and hand feeding assembly from feed valve to "stokehold" floor. This must be the case if J 637 is to be complied with. The capacity of distilled water tanks are never extravagant although there are sometimes two direct evaporation fresh water generators in the system. The output of each can be in the 45 tons/day range when they are not being temperamental. Possibly it is because of this theoretical high output of the fresh water generators that E 708 which asks for a feedpump sea-suction is rarely complied with. The life of a modern high evaporation rate water tube boiler could be measured in hours if not minutes should sea water feed be used.

Once again as with other machinery the feed pump chocks and alignment are examined. Most pumps now have turbine to pump couplings totally enclosed or on the same shaft, and one must rely on stringent chock tolerances and correctly adjusted pipe hangers for a satisfactory set up. All safety features such as overspeed, back pressure and loss of lubricating oil, together with feed output regulators (E 705), and loss of feed pressure, should be proved satisfactory before the pumps go into commission.

It is well to set positioning of boiler water level gauges prior to the hydraulic tests, as any re-location to place them in a better viewing position (to the satisfaction of the Surveyor—J 634) can require a substantial part of the plant to be re-tested. As a small note of interest it should be added that some owners are now stipulating one feed pump turbine should incorporate a Curtis wheel so that vacuum problems can be overcome by running this pump direct to atmosphere without detrimental effect. This may progress to steam turbine driven alternators.

Rpt. 4a/4b/4f (Inst)
Part 2 Sheet 4

FEED SYSTEM

Heaters

Enter in box number of following feed heaters fitted: H.P. ☐ I.P. ☐ L.P. ☐

Is a deaerator fitted Yes ☐ No ☐ Give number of pressure feed filters fitted ☐

Evaporators

Number fitted ☐ For essential services { Yes ☐ / No } State if { F.W. ☐ State W.P. / S.W. }

Is a S.V. fitted Yes ☐ No ☐

Give positions ......

Is ancillary equipment attached Yes ☐ No ☐

F.W. Generators

Number fitted ☐ For essential services { Yes ☐ / No } Is a steam heating coil fitted { Yes ☐ / No ☐ }

Is a S.V. fitted Yes ☐ No ☐

Give positions ......

Is ancillary equipment attached Yes ☐ No ☐

Condensers

Main. State number ☐ Aux. State number ☐ Give positions of aux. condensers ......

Air ejectors or E/D Vacuum Pumps

Main. State number ☐ Give positions ......

Steam Generator and/or Feed Heater Drain Coolers

State which, if any, are fitted, and give positions ......

FANS

Number of draught fans { Forced ☐ / Induced ☐ } Type of drive { Steam ☐ / Electric ☐ } Positions { ...... }

F.W. and L.O. COOLERS

		Positions		
M.E. F.W. coolers	☐	......	......	......
M.E. Piston F.W. coolers	☐	......	......	......
M.E. Jacket F.W. coolers	☐	......	......	......
M.E. L.O. coolers	☐	......	......	......
Aux. E. independent F.W. coolers	☐	......	......	......
Aux. E. independent L.O. coolers	☐	......	......	......
M.E. Blower Air coolers	☐	......	......	......
M.E. Blower L.O. coolers	☐	......	......	......

O.F. HEATERS

		Position of each		
Number of boiler O.F. unit heaters. Main	☐	......	......	......
Aux.	☐	......	......	......
Number of M.E. H.V.F. heaters (incl. boosters)	☐	......	......	......
Number of purifier/clarifier H.V.F. heaters	☐	......	......	......

Fig. 9.6

(d) **Lubricating Oil**

In general the lub-oil lines are constructed of galvanised steel piping (E 908). A wander around the area of the pickling vats will give one a chance to examine random lengths concerning cleanliness (E 909). Any pressure testing of the butt-welds on these pipes should, of course, be done before the galvanising process. The main turbine gearing lub-oil sump tanks built into the hull are often stepped, slanting and generally of an unusual shape. The location of the pump suction becomes a difficult problem if E 910 is to be adhered to. This requires a suction under the conditions of 15° angle to port or starboard, 10° pitching and 22·5° rolling from the vertical. The maximum size of filter element openings are stated to be 50 microns (2 thou.) and there should be magnets incorporated in the arrangement (E 908). The pump, if of the rotating type, should have a non-return valve on the discharge side (E 902), and the factory adjusted relief valve can be tested by closing this valve when testing lub-oil failure alarms, or start-up of the stand-by pump (E 905 and E 904). At times there are oil header gravity tanks up to which the oil is first pumped. These should have remote shut-offs (E 912) and gooseneck air vents not less than 2 in diameter (E 406) which can be in the engine room but directed away from machinery items in case of overflow. Normally the emergency supply of oil from the rundown tank is incorporated in the gear housing entablature and has a supply of 6 mins at working temperature (E 905). This supply item can be tested at the spin test or dock trials. Regarding lub-oil systems, cleanliness is next to godliness.

(e) **Steamlines**

Once again plans according to the requirements of E 101, with updated amendments, should be available. On several occasions the phrase "a wander around" of a certain area has been mentioned. This may sound unusual to the uninitiated, but a large part of newconstruction work should involve being in unexpected places at unexpected times in addition to the normal production department notification, that items are ready for examination at a specified date and time. If the names of the welders approved for high pressure pipe welding are jotted down in the old style notebook (not the new tear-off type), and should a new face crop up, a query can be directed to the Senior Welding Engineer concerning proof of welding procedure tests and their date of execution (E 520). A list of steam pipe thickness's, diameters, material of flanges and other points mentioned in E 101 is also a useful "jotting" in this notebook, together with a small pair of calipers (E 511). This information is incorporated in the F.E. Report but will be dealt with later. The conditions of pre-heat can be tested randomly with a tempstick and butt alignment to one-tenth of the wall thickness (local limits) proved with a straight edge. Weld undercut (E 518) and internal defects should not be accepted and steps should be taken to rectify these faults if they show up visually on site or from the X-rays. An attendance at the non-destructive testing radiography course is essential as discussions about flaws can be heated, because repairs to h.p. pipe welds require reheat treatment and this takes time and money. The requirements of J 420 and J 423 are a useful crutch to fall back on concerning radiography standards (Ref. 7). Butt-welds in pipe diameters over 76 mm for working conditions over 17,5 kp or 220°C are preferably to be X-rayed.

During examinations on board a lookout should be kept for any unusual valves that may have been mistakenly incorporated in the system. Bronze valves may be used up to 218°C–10,5 kp/cm, iron 14°C higher with the same pressure and carbon steels 454°C and all pressures. The composition of higher temperature valves are exotic mixes of basic chrome-moly with variations on the additions (E 605). During the life of the ship these steam lines will have to be examined at intervals as stated in C 1101 and Instructions to Surveyors (6b) 1967. This shows that saturated and superheated steam pipes, where the temperature of the steam is below 450°C are not going to be officially re-examined for the next eight years. High pressure pipes, where the temperature is above 450°C, not before an interval of four years. A transfer from the newbuilding yard may have taken place in this time and one could be examining one's own mistakes. The steampipe lengths are selected according to C 1102: bolted pipes over 75 mm internal diameter are to be tested in rotation to 1,5 times the working pressure. C 1103 states welded joint pipes are to be tested to 1,5×W.P. and crack detected at welds in rotation over the life of the system. As an aid to colleagues dealing with Steam Pipe Survey surveys a general arrangement plan (E 101) of all the h.p. and l.p. lines can be arranged, having the position of each weld marked on the plan. Each pipe length can be given a designated number and copies of these plans made; one to remain on board for the visiting Surveyor and one copy in London with the F.E. Report. How else can one ensure the lengths are seen in rotation? An additional help can be arranged at the yard by asking the department dealing with insulation, to arrange removable sections of the metal clad insulation (asbestos pillows are out-dated) in the areas of welds. Crack detection or ultrasonic examinations can then be carried out reasonably easily and at a lower cost to the shipowner. Besides the two non-destructive testing methods mentioned, one could arrange to have the newbuilding weld X-rays left on board for comparison against any radiography carried out at a later date and so be able to positively identify weld deterioration. Pipe bend erosion is another matter not so easily remedied concerning means of positive examination.

Methodical random checks should be carried out on pipelines working over 17,5 kp/cm² (E 508–E 523(b)) and copper pipes over 10,5 kp/cm² (E 523(a)) whilst subjected hydraulic pressures are sufficient to maintain a high standard of local examinations by local bodies. If time permits personal examination of all these items, then this is of course the best procedure. Heating coils in oil fuel, cargo and slop tanks (E 523(c)) have been mentioned earlier.

Care should be taken with the mounting of bellows type expansion pieces in steam (E 601). They are usually mounted the wrong way round and it is difficult to check the flow direction when connected in line. A collapsed concertina shape on one edge and an elongated length on the other cuts down the material life to weeks and so parallel alignment is important.

The steam for the self-lubricating piston of the windlass normally comes from a wet supply such as a steam/steam generator. This can be supplemented by an emergency supply from the external desuperheater and through a reducing valve. Should the latter system be the case then compliance with E 604 is essential. On the boiler scum and blow down lines it should be remembered that there should be a spigot and doubler at the ship's side (E 268–9).

(f) **Oil Fuel**

It was stated in the section on boiler feed that testing of bolted steel lines above 17,5 kp/cm² or 220°C working

conditions usually took place in the workshops. The requirements of E 310 and E 523(c) state that this piping system is then to be tested after jointing to twice the working pressure, or 3,5 kp/cm^2 whichever is the greater (E 312). It is suggested this be interpreted as being when the assembly is jointed on board rather than in the workshops (E 317). During these tests one can check if the line flanges are placed in view (E 310) and away from heated surfaces and electrical appliances (E 339). It may be remembered these items were first mentioned when discussing the model.

The oil fuel units themselves should once again have chocks and coupling alignment proved. Although the pump relief valve is factory adjusted one should see at what pressure it lifts and then adjust the heater oil relief valves to 3,5 kp/cm^2 above this pressure (E 308). Should the overpressure from the heater return to its suction and re-circulate until rectification is attempted by an engineer, the pump will invariably seize up as the oil, although slightly pre-heated in the settling tanks is a coolant to a worm-type pump. When the heater overpressure valve returns to other positions (E 308) one should check if the flow meters are situated before or after the relief valve. Fluctuating oil demands from the boiler and slow automation response can cause the oil relief valve to lift and should the return be to the settling tank, the fuel consumption will appear to be a fantastic amount, although it is only re-circulating within the system and not being burnt at the tips. Concerning burners and burner tips, the final pipe lengths can be of flexible design if of approved material (E 311) but one should not let the layout become such a fire hazard as shown in Plate 9.4.

The oil fuel tanks, whether for storage or settling out of water and sediment, usually incorporate internal heating coils. These must be tested to twice the maximum steam pressure they can be subjected to when they have been installed on board (E 335). Whilst in the tank one can ascertain if thermometer pockets have been fitted and ensure they are situated away from the heating coil inlet or outlet pipes as a false impression of the overall temperature of the oil in the tank will be obtained (E 327). Any water or sediment drains (E 328) should be lower than suctions to allow cleaning of the tank of these items rather than allow the system to become contaminated. There are usually high level alarms (E 408) on each tank and these can be tested by hand as it was messy when they did not function when tested realistically. Any sounding devices other than hand dip-stick (E 414) should be tested but to correlate readings with quantities can be difficult due to the unusual shapes and quantity of steel framing and stiffening when tanks are part of the hull structure. Prepared graphical readings must unfortunately be accepted at face value.

Situated around the ship are fuel containers for the diesels of emergency fire pump, emergency alternator and main diesel alternators. These tanks are to be constructed and tested according to the requirements of E 327. Their airpipes to deck should be fitted as usual with non-ferrous metal gauzes (E 403) on the open ends. The sight level glasses of the tanks must be heat resistant glass (E 415) and have self-closing valves and remote control shut-off valves (E 316) on their outlet lines. A manufacturer's certificate for the glass will state any temperature tests that have been carried out. At times these gas-oil, or diesel-oil tanks are incorporated in the boiler first flash-up arrangements (E 307) and the possibility for this to be achieved could be proved whilst running the hand start air compressor or auxiliary alternator, whichever is fitted.

Finally, when wandering around the engine room checking pumps, etc., one can examine double bottom sounding pipes and ensure they are located away from electrical equipment and have automatic self-closing cocks attached to their upper ends (E 413). Nameplates must be in evidence and are preferably verified at the end of the sea trials, when they are more likely to have been completed and affixed.

(g) **Liquid CO_2**

The reason for adding a short section on CO_2 piping is primarily for the requirements of testing. H.P. systems are obviously well covered by rule requirements for piping, but the use of l.p. liquid CO_2 for fire extinguishing, carried at 300 lb/in^2 and $-18°C$ is becoming more popular. It has to be decided if our refrigeration rule requirements are applicable in any way or to treat the system as for a normal high pressure layout. An excellent guide to have is a small booklet issued by the British Fire Protection Systems Association Ltd., entitled "Installation and testing of pipework in low pressure CO_2 fire-extinguishing systems". This gives a diagrammatic layout of the system showing the insulated container carrying the liquid CO_2, those pipelines that are permanently under pressure, intermittently pressurized and open ended. Each section having separate test pressures and requirements. As we are using so many International Standards as guide lines (I.E.C. for electrical apparatus, etc.) it should be reasonable to assume the informative contents of this booklet could be a discussion point concerning l.p. CO_2 system testing on board ship.

Rules F 509 and F 216 consider an international shore connection for the fire extinguishing water main to be essential and to be constructed in a specified manner. This ought now to be extended to the filling line of this l.p. liquid CO_2 system. The first layout at this yard was of British manufacture and when the local road tanker arrived to fill the system it was found that the British thread on board and the metric thread of the road tanker hose could not be mated. This was solved eventually with a hastily fabricated union which was left on board the ship when she sailed. Although the manufacturers now supply such an essential connection it is not mandatory as far as l.p. CO_2 systems are concerned.

Of Special Interest to the Surveyor

(i) Circular No. 2275 is applicable if the ship is to the Netherlands Flag.

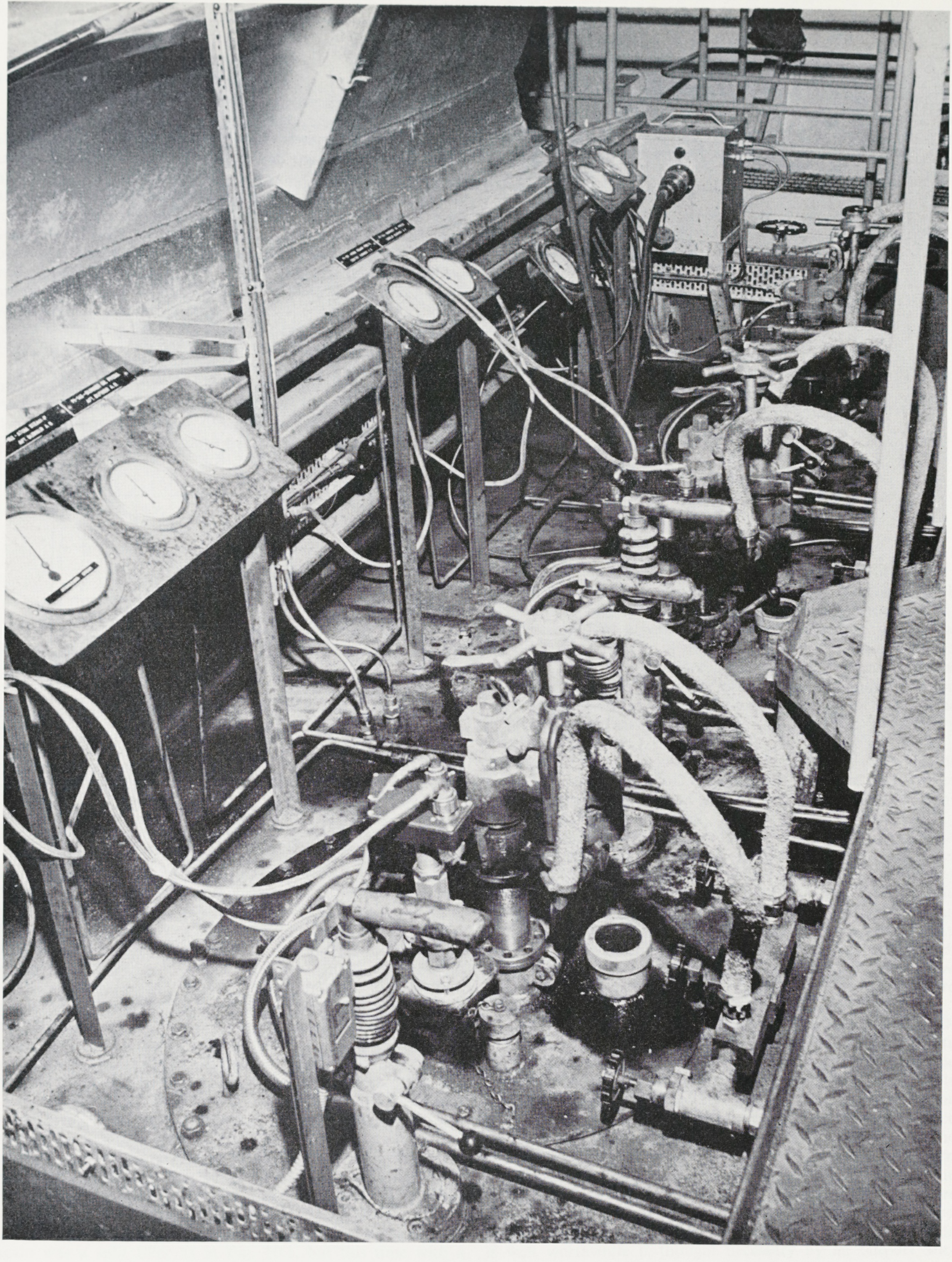


Plate 9.4

Rpt. 4/4a/4b/4f (Inst)
Part 2 Sheet 5

INDEPENDENT PUMPS and EDUCTORS

In Description column name ALL pumps other than domestic. State positions and give bilge pump capacities.

In Drive column indicate
E for electric drive
SE for steam engine drive
ST for turbine drive
D for diesel drive
H for hydraulic drive (*see foot of page*)

Enter pumps in following sequence
Emergency fire
Fire
Central priming
Bilge
Ballast
G.S.
Main & Aux. S.W. Circ.
Main & Aux. F.W. Circ.
Extraction
Feed
Forced circulating
L.O. circulating } state which service
O.F. transfer } state which service
O.F. service } state which service

DESCRIPTION	DRIVE	*Service for which pump is connected to be marked with an X*																			
		SUCTIONS										DISCHARGES									
		BILGE MAIN	BILGE DIRECT	BALLAST MAIN	O.F. TANKS	COND:EXTRACTION	SEA	FEED TANKS				BOILER FEED	MN. CONDENSER	O.F. BURNERS	O.F. TANKS	FIRE MAIN	OVERBOARD				

HYDRAULIC DRIVES (Give details of power source for all essential machinery hydraulically driven)

FIG. 9.7

10. Rudder Stock and Tiller

What follows might be slightly controversial, but is inspired by several unusual cases encountered recently. Information elicited from local people experienced enough to give a knowledgeable answer, state that it would appear split type tillers have been predominantly a Scandinavian owners' requirement and ease of dismantling being the idea behind design. In the smaller designs the split tillers would appear to have been adequate for the purpose of turning a ship safely and have been reasonably free from defect. However, several vessels with rudder stocks diameters of 700 mm and over, are at this moment, floating around the ocean with tensioning straps welded across the flange-faces due to the tiller having slipped on its stock. One key was subsequently refitted in Rotterdam. Fig. 10.1 shows a standard split tiller, single solid key design.

All plans for this area of building are normally retained by hull colleagues, Shipyard Hull Department, and Owners' Naval Architect's Department. This knowledge might save correspondence and time to anyone unwittingly writing to Head Office Engine Departments for information. Calculations for rudder,

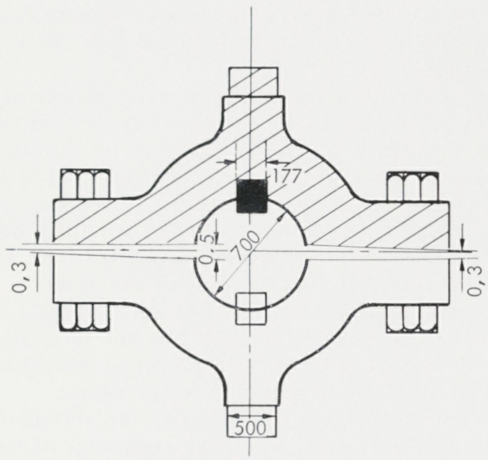


FIG. 10.1

bearing, stock, key and keyway sizes are dealt with by the shipyard naval architecture department, and enquiries should be directed to this area: again merely a case of where to look. These calculations and this information are forwarded to the Ship Department in Head Office for approval and returned to ship colleagues at the port. This is excellent, but one should be aware of the system. However, here the system might fail, if one group were of the opinion that once the rudder stock protruded into engine space it is no longer of interest and the other faction believing that as plans, calculations, etc., are not dealt with by them, conclude that the fitting of components according to requirements stated on these plans, are therefore not within their sphere, a blind spot may sometimes be created. This might also be valid for bilge pumping arrangements in the steering gear flat, sea connection suction boxes, propellers, pump room light fittings, steering gear design, windlass design and testing, turbine and condenser foundations (D 109), main boiler blowdown cocks at shipside, alignment of tailshaft and boring out, CO_2 system and fire pipeline plans.

Recently a ship had a tiller slip whilst on sea trials. This again was a split tiller as in Fig. 10.1, but this time with a split key in the keyway as it was thought the previous solid

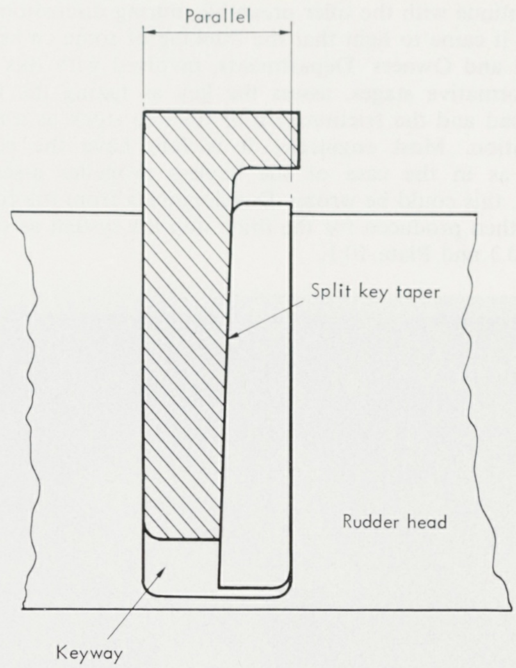


FIG. 10.2

key in keyways was a cumbersome design to fit over a length of 900 mm. Fig. 10.2 shows the split key arrangement.

The temporary expedient to allow these vessels to continue in service was to weld metal straps top and bottom, forward and aft, on half of the tiller. Heat the free sections of straps and then weld them onto the other half. The contraction on cooling of the straps pulling the two halves tighter around the rudder stock. This would imply the grip was of primary importance (D 2310).

During the second mishap it was decided to request one of the Surveyors from T.I.D. to come on a re-trial and witness the problems. The keyway halves had opened at the horns due to plastic deformation at this stage. With the ship anchored and wires to the rudder to centralise it, the T.I.D. Surveyor decided to place strain gauges around the tiller halves, slack off the bolts and measure for the suggested over tightening. The final report from T.I.D. states the bolts did not appear to have been tightened enough, although manufacturers and design approval were of the opinion that 9 tons/ft is the maximum allowable limit of tightening each bolt. It would be interesting to hear if any colleagues have had a similar instance to this, maybe it would help for future cases.

As this will be the only instance of mentioning the T.I.D. Department it is thought a short digression will be appropriate here to mention these trouble shooters as seen through the eyes of one outport Surveyor having requested a few visits from them over a range of serious problems. It is one of the few occasions when a promise to the shipyard to produce someone, to proffer a suggestion towards a solution or the answer to a problem can be guaranteed. Their ability to turn up in the strangest places at the allotted time, is amazing. The knowledge that they do turn up is a great confidence builder to an outport Surveyor encountering technical troubles beyond his ken. The usage of this section of the Society's many aids is well worthwhile if thought necessary by an outport Surveyor.

To continue with the tiller preamble, during discussions that followed it came to light that the thinking of some colleagues, Shipyard and Owners' Departments, involved with this work in the formative stages, assess the key as taking the major torque load and the friction grip of tiller to stock as a minor consideration. Most engineers, it is felt, have the reverse opinion, as in the case of the keyless propeller assembly. However, this could be wrong. Developments from the former thinking then produced for the third ship the system as shown in Fig. 10.3 and Plate 10.1.

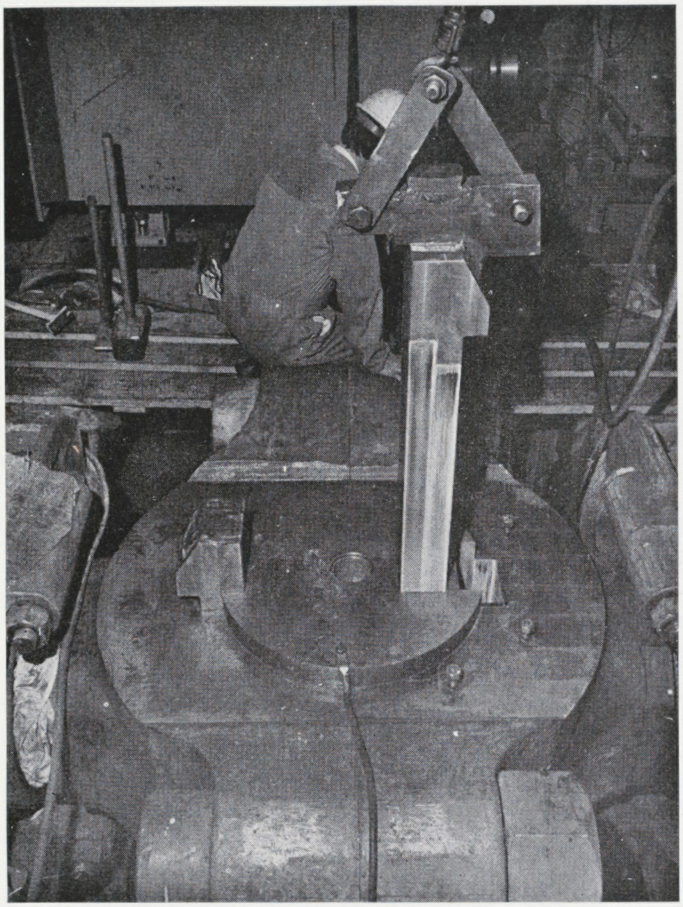


PLATE 10.1

Split tiller with two keys.

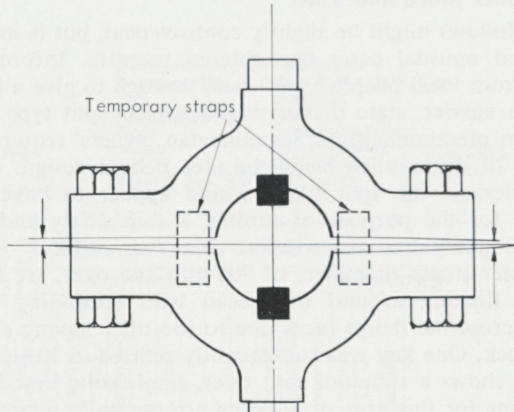


FIG. 10.3

Fig. 10.3 shows the tiller with two solid keys in two keyways. To fit this and keep both keyway side faces parallel after tensioning is rather difficult and requires one key to be slightly stepped.

Plate 10.2 shows how the bolt tensioning spanner of known length is pulled by hydraulic means of known cylinder diameter so giving the 9 ton/ft as requested by manufacturers, A quadrant and clock gauge can be seen to straddle the bolt length to measure lack of elongation (there has been no stretching to date). On completion, the two tiller halves lie with a gap at the stock of approximately 0,8 mm, and 0,35 mm at the outside edges, not touching at any point.

In conclusion, this expatiation has been initially used to highlight a condtion which to date has not received a final remedy, and secondly to open the subject to discussion for a possible final satisfactory solution for the future.

For the immediate future at Odense the shrunk fit tiller will replace the two halves type. The expansion of the metal mass of the solid tiller to achieve a shrink (D 2310) fit is now obtained by borrowing the induction annealing wire from the high pressure pipe shop and wrapping it around the casting and then heating up. The tiller can then be lowered onto the stock under controlled heat conditions, rather than have to worry about quick shrinkage and subsequent jamming of parts when the butane heaters are removed before lowering of the casting commences.

For the long term increase in size of components and loading, the use of taper and pilgrim nut is being investigated.

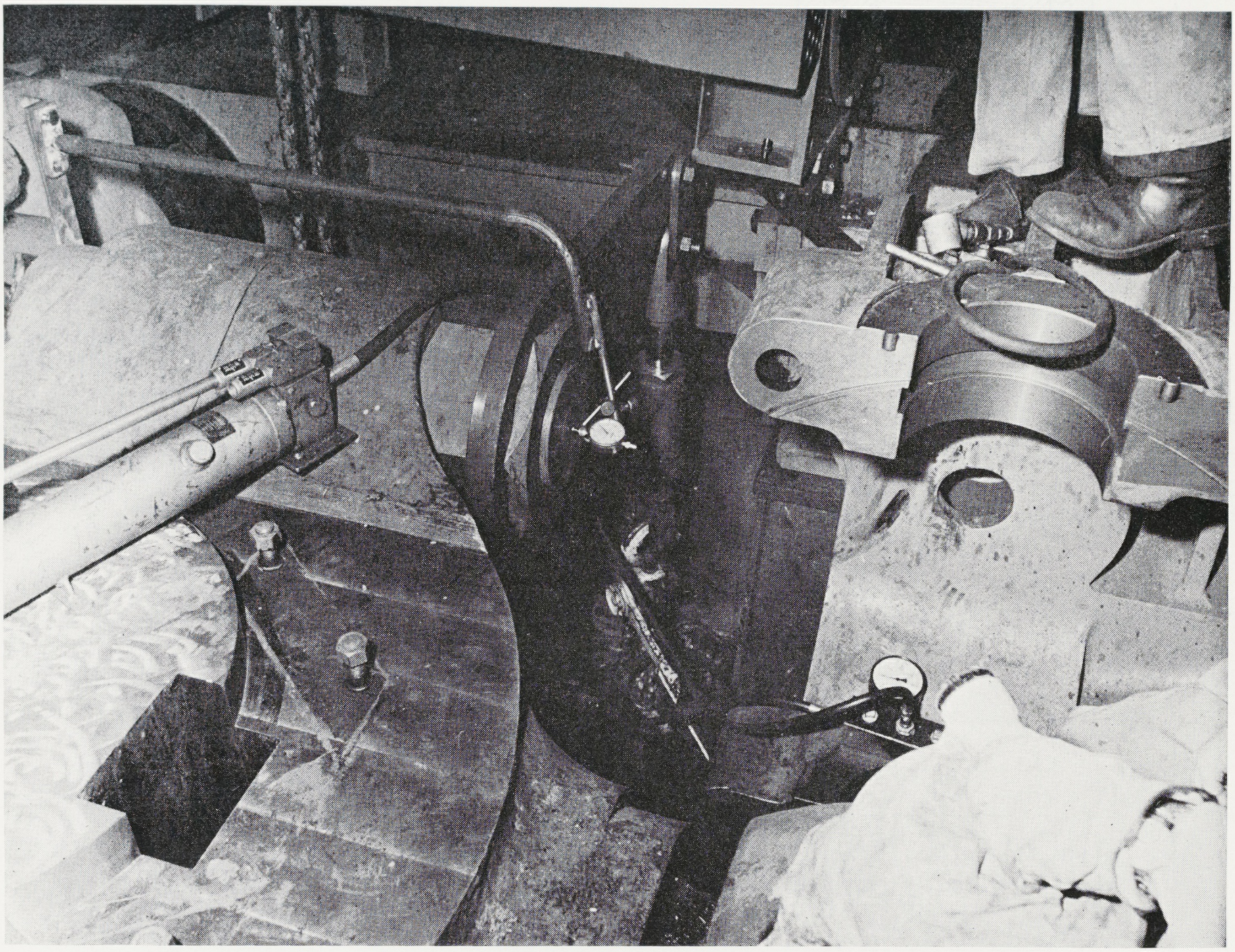


Plate 10.2

Hydraulic tensioning equipment and measuring saddle chock-gauge.

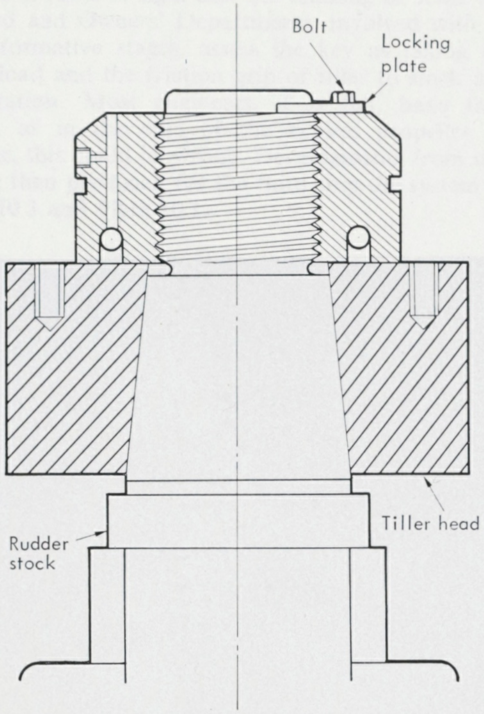


FIG. 10.4

Diagram showing a Pilgrim nut in section on the tiller head. Hydraulic connections to the nitrile tyre can be seen at the left of the nut.

Of Special Interest to the Surveyor

1. Fitting of two halves of tiller to stock or shrink fit dependent on type.
2. Fit of key in keyway (keyways).
3. Carrier thrust bearing and oil grease points to test.
4. Alignment of electric motors to hydraulic pumps.
5. Testing at pre-sea trial and sea trial (D 2302).
6. Holding down bolts and chocks (G 110, D 2301, D 2309).
7. The auxiliary steering gear test of D 2301 is unnecessary if two systems are fitted (D 2305).
8. Check the bridge and steering gear helm indicator show the same (M 506, D 2307).
9. Test the overload alarm (M 506(a)) with a transformer to give an induced overload. Overcurrent recommended setting 200 per cent (Rule recommendations Section 6).
10. Test running indicators (M 506).
11. Check the sources of supply are port and starboard of ship or from the emergency and main boards (M 506).

For F.E. Report

1. Stampings of components and motors for inclusion in list of certificates.
2. Dates of fitting.

STEERING GEAR

Maker .... Type ....

Number of powered units .... Relative positions ....

Alternative steering arrangements ....

WINDLASS

State number fitted ☐ Give position ....

Is drive: Steam ☐ Electric ☐ Hydraulic ☐ If hydraulic, give source of power ....

COMPRESSORS and AIR RECEIVERS

Give details of ALL Compressors

Number	Duty	Capacity	Separator or filter fitted	Prime mover	Position in ship

Max. W.P. of starting air system ....

How are Rule requirements met for first charging of air receivers ....

Are safety devices in accordance with the Rules ....

Are bursting discs or flame arresters fitted at starting air valves on each cylinder ....

Give details of ALL Air Receivers

Number	Duty	Capacity	Position in ship

Has manœuvring of M.E. been tested and found satisfactory ....

Where electric starting is employed, state briefly how initial start is obtained as per Rule ....

Fig. 10.5

11. Control Equipment

Being a Surveyor of the same country from which the automation equipment originates, can leave one open to receiving a considerable amount of comment from non-expatriates of that country, when things go wrong or components fail. The shipowner or yard tend to forget that it is the outlay of money which determines the quality of equipment and at times expect too much. Surveyors have very little say in the choice of material other than that of environmentally testing certain items. However, more can be said on the testing of equipment in circuit on board. It is in this field of control engineering at the newbuilding testing stages, where there is still room for original thought. It is well known that preoccupation with rules does not sit well upon the creative mind, and possibly it is because Chapter L is only two and a half pages long that this chance to experiment arises. Obviously as experience feedback increases from in-service installations, the rule requirements will increase and envelope test procedures as in other sections of the Rules.

Healthy basic tools of the trade to have at hand are as follows: —

(a) Control Engineering Equipment, Chapter L Rules,

(b) Instructions to Surveyors Part 6b, Control Engineering. Although one needs the 1969 Rule Book to interpret the contents it is still very good material even today,

(c) Recommended Code of Procedure for Marine Instrumentation Control Equipment,

(d) "Papers" by Dr. S. Archer, D. Gray and A. R. Hinson,

(e) Fire Protection, Detection and Extinction, Chapter F of the Rules.

With these basic items and sufficient time one can fill out the F.E. Report on Control Equipment and also feel reasonably satisfied about the function of each section. At this point a comment should be interjected about the Automation Course. It is felt that the subject might be re-orientated to show, not how a circuit is set up, but basics of how it should not be assembled. This could be argued on the lines of which came first, the hen or the egg, but there is a greater chance of learning basic mistakes applicable to all systems, than all system types.

It is physically impossible to test every system involved in a modern plant in the time available. Faith in the ability of sub-contractor and shipyard test department is necessary for some of the items. In this context it is then essential to make oneself a detailed priorities list. Those items dealing with safety of life at the top (boiler low water level shut downs, boiler furnace purge cycles, etc.), working down through safety of the ship, machinery and allocating each main section sub-priorities. As much as possible should be done as fully as possible and as realistically as possible whilst eliminating trivia, e.g. hydrazine injection, bridge control. (Bridge control on tankers is included as trivia because if one asks the Deck Department how it is functioning they reply they don't know as it is only needed once a month and even then they do not use it but have engineers manœuvring during stand-by duties.) In the case of a UMS notation it is obvious that the items enumerated in Chapter L to obtain the notation are paramount.

In the early days control systems had stark simplicity. Now we are faced with items that can be complex nightmares to the beginner. This abundance and complexity of controlled plant is such that in times of adversity the mind undoubtedly works at the speed of light but not enlightenment.

Working in the Main Control Room of a V.L.C.C. during testing (which at times coincides with the electrical testing), requires a special state of mind. If one is prepared to be helpful, then too many things are simulated and half tested. If one is too unbending and things go wrong, when one enquires of the problem, the information is often incomplete, untrue, irrelevant, suppressed or distorted in order to placate, again useless and frustrating. Language barriers between sub-contract engineers of different nationalities can cause a reasonable percentage of poor and inefficient testing of circuits.

In this section of the paper it would be ridiculous to attempt to work through individual circuits or systems, as each company has vastly different conceptions of automation. The common denominator throughout are the Rule Requirements needed in the case of a ship requiring a UMS notation. A point arises here where it can be interjected that certain other Classification Societies and National Authorities require a specified period of hours for the machinery space to be unattended prior to issuing the certificate. It would be a strong working point if the Society had such a recommendation written into the Rules.

A table of automatic functions as shown in the microphotograph are a lucid aid to what is happening at each point. The Yard Control Engineering Department should be requested to compile such a sheet. This, together with the items requested in Chapter L, such as trial sheets for initial check and adjustments, trial sheets for dock and sea trials, etc., form the bases of records that must be both detailed and meticulously kept.

Several automated diesel driven V.L.C.C.'s have left Odense which appeared straightforward and functioned reasonably satisfactorily during the guarantee year. However, the first 250 000 ton dw steam turbine ship that was intended to hold, but was not given, the UMS Certificate was early in 1969. To say it was unsuccessful is an understatement. It was read with anguish, what would appear to be its serialised obituary in the casualty columns of Lloyd's List.

Control systems usually fall into the categories pneumatic or electronic. Most crews arriving during newbuilding prefer the pneumatic, as they say it is more marine engineering than the latter. It is not so many years ago that some engineers would refuse to sign on a ship when they learnt it was an a.c. not d.c. electrical supply. Old lessons die hard.

The problem most frequently reported back concerning the pneumatic layouts is contaminated air, irrespective of the multitude of intercoolers, driers, separators, etc. Oil and water (but mostly the former) migrate along the lines and accumulates in bends, loops and distribution points. During newbuilding the simple expedient of ensuring that all sub-pipes in the control cabinets emanate from the top of an air distribution pig and not the bottom, helps a little, especially if this distribution point is sloped and fitted with a drain. Small details but they give big results.

On the electronic side it is reported that voltage surge from sequential start of pumps give spikes which effect the transistorized components. A suitable or reliable filtering system does not appear to be available at the right price at the moment. Many circuits have to be repeatedly recalibrated with the potentiometer although test equipment battery drift and other points are checked constantly during initial testing. Poor joints at the signal end, when dry and vibrating tend to alter readings also. To fault-find in a circuit with pneumatic and electronic equipment is "interesting" to say the least.

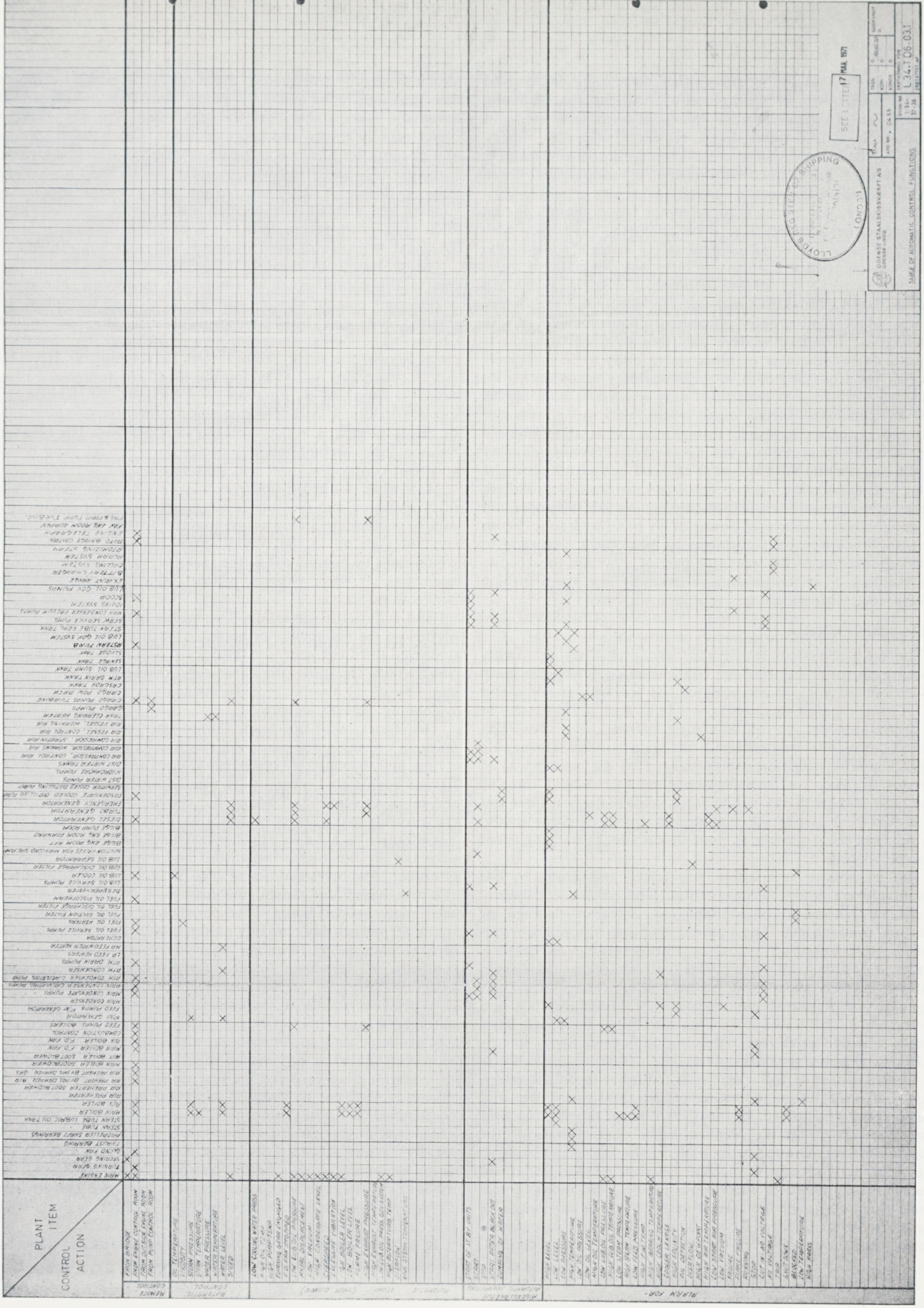


TABLE OF AUTOMATIC CONTROL FUNCTIONS
ODENSE STAALSKIBSVAERFT A/S

FIG. 11.1

An L.R.T.A. paper on automation gives an excellent and concise breakdown of testing methods (all non-participating workers out of engine room to give quiet conditions, etc.) and would be ideal if it was allowed. However, in reality, money and time factors prevail and so a compromise is obtained. Regardless of the factors mentioned it is essential that those circuits tested do not entail simulation in part or whole if in the Category A.I. essential to safety of life or vessel. In the following true anecdote it will be attempted to convey how important it is to test all control safety circuits realistically. (This can be applied in most instances but especially in those installations receiving a UMS notation. For the record UMS denotes UNATTENDED and not UNMANNED machinery spaces. Most photographs of control rooms devoid of life would make it appear it were they that were unattended.) It is usual for an engineer or other warm body to be in attendance in the Control Room in the machinery space during *en route* passage. In-port conditions may well leave both spaces free of personnel during night hours with the alarms for essential systems distributed throughout the accommodation. According to local reports, the number of times the majority of the engineering faculty spend trapped in the lift during a panic and subsequent blackout until services are re-established, has certain companies contemplating having this item operated on an emergency source of power or by hand hydraulic. From time to time pressure is brought to bear on a Surveyor to allow simulation of the whole or part of a system to expedite the building or commissioning programme (e.g. main turbine overspeeds). This should be resisted at all costs.

Tribulation on Trials

The oil fuel system which had been previously simulation tested gave trouble during sea trial, when supplying the main boiler of 111 tons/hr evaporation, 81 kp/cm^2 pressure and 513°C superheat. The cause was a failure of the pressurestat or transducer, on the oil fuel filter before the pumps. The filter was of the duplex hand changeover, non-selfcleaning type. The filter after the pumps and before the heaters was of the rotary motorised selfcleaning type. One would imagine that most foreign matter would accumulate in the first filter and so would be better if selfcleaning. As approved plans should be adhered to as closely as possible on site, the arrangement was not modified.

The transducer in question was tested and preset by the manufacturers prior to installation. The subsequent failure could be reasonably attributable to in-transit damage or erection mishandling. The internal damage was not obvious during installation on board or during testing as contacts before the instrument were bridged, so simulating diaphragm out of balance due to oil pressure drop. The system was regarded as of minor importance in this one instance and so the alarm was tested in this manner. What happened later, due to this one small item, stretches one's credulity.

Let us visualise a period midnight to 0400 hours, en route to the trials area at full speed, half loaded with ballast water, tank bulkhead testing being in progress. Most of the trial participants were asleep. In the control room taped music was issuing quietly from the speaker in the control console; the data logger was chattering to itself in the corner. Outside in the machinery space the oil fuel filter in service on stream reaches contamination saturation point. The faulty transducer fails to register the dangerous situation by not initiating the alarm in the Control Room. The pump in service becomes starved and as the oil from the settling tank acts as a coolant, although slightly pre-heated, the screw type pump overheats and seizes up. The stand-by pump starts up on sequential automatic start and suffers the same fate. The lines to the boiler rapidly empty and pressure drops. The burners sputter and go out. An alarm is initiated—flame failure. The turbine manœuvring valve is fully open and the 32 000 shp turbines are gulping steam. A 2500 shp cargo pump steam turbine is running and a steam turbine feed water pump. The 1280 kW, 2000 amp steam turbo-alternator is carrying substantial load. The next sequence of events happen with startling rapidity.

The boiler steam pressure gauge needle winds itself back due to the consumption of equipment in service. The main engine runs on, but slowing rapidly. The cargo turbine slows slightly, but very little change occurs to the feed pump delivery. The loaded alternator slows down and the frequency meter shows the cycle falling from the normal 60 Hz. The A.V.R. maintains 440 volts and the load. The preference trips begin to snap out at intervals of 5 seconds, 10 seconds, 15 seconds, shedding load. The frequency drop activates the stand-by diesel alternator, which cycles to start position. The breaker holds a little beyond fall out cycles on a pre-set time delay and then comes black-out and shut down.

Meanwhile the main boiler is filling with water as the rate of evaporation and pressure is not maintained. The electrically driven condensate pump is no longer feeding the de-aerator situated high up in the funnel space, the head and level of which can't be maintained as the make-up valve, although fully open, has no water passing through. The feed pump suction begins to be starved to seizure stage. The stand-by pump starts up and suffers the same fate. The bridge is telephoning down, alarms on the emergency or battery system are blaring and the unnerved third engineer is in the corner, writing out his resignation. From the time the frequency reached 58 Hz to the stand-by diesel alternator being started up, synchronising and re-loading, was 55 seconds.

The diesel takes the load. Pumps and systems in general start up on sequential start. All this has happened in so short a time and through one small transducer failing and the circuit having been tested partially by simulation instead of shutting the oil at the tank and letting the system drain and seeing if the pressurestat worked realistically. This latter method was not allowed as a boiler shutdown would interfere with other activities in the highly organized and overlapping test programme. An investigation at the rear of the automation cabinets began and finally the fault was traced to the filter after many wasted hours. This sequence of analysis is symptomatic of present-day complex atuomation systems. The fundamental engineering thinking of yesteryear is befogged by thoughts of derivitive, linear, exponential and square root relays.

As previously stated this actually happened on one of the earlier automated tankers. Luckily there were many sea-trial specialists available and so the consequences were not too serious. However, the point it is wished to make to a Surveyor coming to a newbuilding yard for the first time on such V.L.C.C.'s is that it is essential to avoid "simulation during testing", and be detailed in those tests one is able to achieve. There are exceptions to the rule, of course—rotor vibration, axial thrust (H 809). When a failure does cost money the apportioning of costs sometimes comes before arbitration and the tests, the method of testing and who witnessed them are delved into fully. Systems can be tested realistically and conclusively with a little inventiveness.

In local circles at Odense it has been suggested the stand-by

diesel alternator autostart and synchronising (not mandatory) could be accelerated and so prevent black-out, but as yet systems have not incorporated this device.

In General

At times bilge level alarm floats are lifted by hand rather than initiate the task of finding a hose and filling the wells with water. Some of the floats have been of corrodible metal or non-fireproof plastic and had handling or corrosion perforations. This was only found when they failed to float.

Consideration is now given to circuits that are sensitive to pickup fluctuations. In many cases if automatic registering device circuits are located physically close to electrical cables subject to surges the alarms will register due to interference pickup. Cargo pump tachometers proved useless until the lines were moved a good distance away.

Many of the sea-going staff that report to the shipyard to witness newbuilding progress and subsequently sail the ship, state that at times things are over automated. It is known that at one time at sea, if anything stood still it was painted. Now, if it moves you alarm or automate it. A very recent case showed a weakness in location of an alarm. During prolonged astern running in order to adjust bridge controls, the L.P. rotor expanded slightly but the thin casing expanded further. The alarm points moved away from one another and the rotor and stator touched and welded on the aft side so showing the casing expansion elongation to be greater than the allowed clearance on the rear of the blades (H 808). There has now been incorporated a double-beat alarm to cover this point (H 809).

When entering a boiler drum steam side one is always particular to assure oneself that steam from other sources cannot enter the boiler whilst internal examinations are in progress. This caution should be extended to furnace examinations in the following manner. Whilst carrying out a water tube boiler furnace examination during commissioning it was noted that the flame sensor pickup was live. All felt safe as the fan must start on purge before the cycle to light up is achieved. On coming out of the boiler it was seen that an electronics engineer had a piece of wire and was bridging terminals to test circuits in the combustion console. One can imagine what by-passing the purge cycles and subsequent light up could have done. It is, therefore, that the main diesel engine crankcase inspection precautionary measure of taking the turning gear fuses with one, should be extended to taking the combustion control circuit module out during furnace inspection.

Finally, to return to the First Entry Report for Control Engineering Equipment, the oil fuel, cargo and fire systems are incorporated on this form also, but these will be dealt with later.

Of Special Interest to the Surveyor

1. Bridging terminals and listening to an alarm only proves there is wire from A to B. Tests should be realistic while the tanker is alongside, tied up and safe.

2. Check a potentiometer and its batteries and terminals before checking systems. This saves time eventually.

3. All items on the F.E. form Fig. 11.2, marked "M", should be completed.

4. If one does not understand the jargon of the control engineer ask for a translation into everyday language. This is one case where one's silence being mistaken for wisdom does not pay off.

5. The best chance to assess if the automation is functioning correctly is during the sea trial economy run as most busy fingers must stop adjusting things during this period.

6. Ensure all plans and descriptions are on file as required (L 102 and L 102(b)).

7. Ensure certificates are available as per L 103, for
   (i) bridge control console
   (ii) boiler control console
   (iii) display, alarm and data consoles.

8. Ensure amendments to subsequent ships are included in plans, etc. (L 104).

9. Check detector heads are away from air currents and the alarm for fire or CO_2 has a different tone (L 205).

NOTE

(i) L 303(b) states turbines should have steam shut-off with no reference to astern steam although H 830 asks for astern braking steam.

(ii) L 303(c) means the lubricating oil pump driven off the main gear which supplies one-third of the oil at all times.

Rpt. UMS Gen.

REPORT ON **CONTROL EQUIPMENT**

FOR CONSIDERATION BY THE COMMITTEE OF LLOYD'S REGISTER OF SHIPPING

Received London

NOTE:—The particulars in this report are to be given as fully and clearly as possible. Where the answer is "NO" or "NONE" say so. Ticks and others signs of doubtful meaning are not to be used. Wording not applicable to be cancelled.

Ship's Name ....   Port ....

Gross tons 143.685   Date of completing rpt. Sept '73   Rpt. No. ....

L.R. Number –   Place of survey, if different from above ....

No. of visits on ship 30   First date July '73   Last date Sept '73

Ship built by ....   Yard No. 100   When Yr. 73 | Mth. 9

Main Engine(s):

~~XXXXX~~   No. of cylinders –

Steam type ....

~~XXXXX~~

Are the main engines reversible? yes

Fee   Expenses

Items below marked † to be considered by H.Q. for UMS notation.

† MAIN CONTROL STATION

Is a main control station fitted? yes

If so:— Where is it located? 3rd deck

Is it fitted in a control room? yes

Is the control room air conditioned? yes

MACHINERY

State the location of the remote or automatic controls (e.g. main control station, local, navigating bridge, etc.) of the following machinery.

† Main Engine	MCS and bridge M	Oil Fuel Transfer System	pump control room M
† ~~XXXXX~~		Evaporating and Distilling Plant	local M
† Main Boiler	MCS and local M	Bilge System	local, high level M alarms in MCR
† Auxiliary Boiler for essential services	local M	Ballasting System	Pumping control system M
† ~~XXXXX~~		Liquid Cargo Pumping System	Pumping control system M
Oil Fuel Filling System	Local and in pump M control room	~~XXXXX~~	
Oil Fuel Storage System	Local and in pump M control room	Windlass	local

† ELECTRIC GENERATING PLANT

Which generators are fitted w~~XXXXX~~? nil

Auto-start, synchronising and paralleling? diesel-& emergency gas turbine

Manual start, synchronising and paralleling from control station? Turbo alternator

~~XXXXX~~

Are controls fitted to heating elements? –

† FIRE DETECTION SYSTEM

What type of detector is used? smoke indicators make ...., type KEA 8021B, thermal indicators make ...., type KEA 4621/70

Manufacturer of detector ....

Where is audible fire alarm fitted? Enc. room (Eng, casing, 2nd dk, 3rd dk, 4th dk platform 8000 AB.TT. floor, emerg. gen.total

Where is fire detector control panel fitted? Wheel house (Chart room)

Date of Committee

Minute

FIG. 11.2

Items below marked † to be considered by H.Q. for UMS notation.

† BILGE LEVEL ALARMS

What type of alarm is used? Mobrey - float high level M

Manufacturer of alarm C.T. Malling, type 843.18/H 843.18 M

How many alarms are fitted? 6 M

Which bilges have alarms? Pumproom No. 1, Eng. Room No. 5 (1 aft. - 2 stbd - 2 port) M

Is a bilge pump started automatically with indication on navigating bridge? No M

LOGGING EQUIPMENT

State how logging is effected for the following machinery (e.g. chart recorder, data logger, by hand).

Main Machinery Chart recorder M

Refrigerated Cargo –

Manufacturer of data logger Honeywell M

Number of inputs? 24 (0-100°C) - 12(0-200°C) - 12(0-600°C) M

Number of alarmed inputs? 22 M

Type of printout mechanism fitted (i.e. typewriter, punched tape, strip printer) Multipoint ink graph recorder M

† ALARM SYSTEM

Is an alarm panel fitted at the following locations for fault conditions which are a potential hazard to the machinery?

Main Control Station? yes Engineer Officer's Accommodation? yes M

Navigating Bridge? yes Navigating Officer's Accommodation? no M

State location of any other alarm panel Chief engineer's office Officers smoke & dining room & duty mess M

DECLARATION TO BE SIGNED BY BUILDERS

To the best of our knowledge this equipment has been installed in conformity with the Rules, Regulations and requirements of Lloyd's Register of Shipping, and the foregoing particulars of the control equipment are correct.

(date) .... (signature) R. Harrison ....

The equipment reported above has been installed under Special Survey in accordance with the Rules, approved plans and Secretary's letters, tested on completion and found satisfactory.
One copy of the Test Schedules, which record that satisfactory local and automatic control has been demonstrated for all equipment and associated instruments and alarms, is forwarded herewith.
The ship is considered suitable for operation with:—

*UNATTENDED machinery spaces. See Chapter L } *delete if not applicable

~~*ATTENDED machinery spaces~~

SURVEYOR'S REMARKS

....
Surveyor to Lloyd's Register of Shipping

FIG. 11.2

12. Emergency Source of Power

Due to the many interesting discussions that have taken place concerning emergency power it is thought worthwhile covering this subject in depth and so throw some light on developments to date. The Society does not require an emergency generator to be fitted; an emergency source of "power" is, however, required by M 111 of the Rules and also by SOLAS 1960.

Emergency generator sets, peak load sets, emergency fire pumps and cargo pumps do not necessarily require construction certificates although survey during construction is encouraged. A comprehensive outline of function requirements for the emergency fire pump is given in F 505 of the Rules. The emergency source of power, not necessarily a generator, has the primary function of being available for "abandon ship" purposes. It is at this point that problems arise if a stand-by diesel or gas turbine is to be used as the source of emergency supply, due to these items requiring safety shutdown devices. However, this point will be referred to later.

In modern large tankers, the consumers for starting from cold or dead condition, can take up to 200 kW or more. The shipowner then feels that, if he has reached this point for start up requirements, why not consider an arrangement a little bigger that can act as a third source of power fed to the main board. Here the compact lightweight high electrical output gas turbine driven alternator is proving ideal for the purpose. Plate 12.1 shows a complete unit being slung on board a tanker. One can see that the total weight of the unit compared to a diesel to give the same output, is far less and so suitable for fulfilling the requirements that an emergency source of supply should be a self-contained unit or source, located above the uppermost deck and outside machinery casings as shown in location in Fig. 12.1.

As this generator must be located in a space not likely to be made inaccessible by fire (if for the dual purpose of inert gas F 314 is applicable regarding location) it follows that it must be compact and light if it is to be placed in the fairly light construction of accommodation spaces. The immedate collapse of the accommodation structure due to fire damage is to be guarded against and the insulation of the room adequate, to allow power to be supplied for at least six hours. The fuel tank capacity and location is important to note concerning this requirement. Some National Authorities require the emergency alternator room to have a permanently installed fire extinguishing system and not portable containers. Where electronic equipment is involved the extinguishing media should be CO_2 in accordance with F 519.

Returning to the duties required of the emergency source of power, in many ships the emergency generator has two functions:—

(a) as a harbour service generator requiring fault shutdown devices,

(b) as an emergency source of power as required by M 111.

In such cases, systems with automatic shutdown devices on the harbour service arrangement would not meet with conditions for the emergency source of supply unless special arrangements are incorporated in the protection systems. If batteries of adequate capacity were provided, intended as the

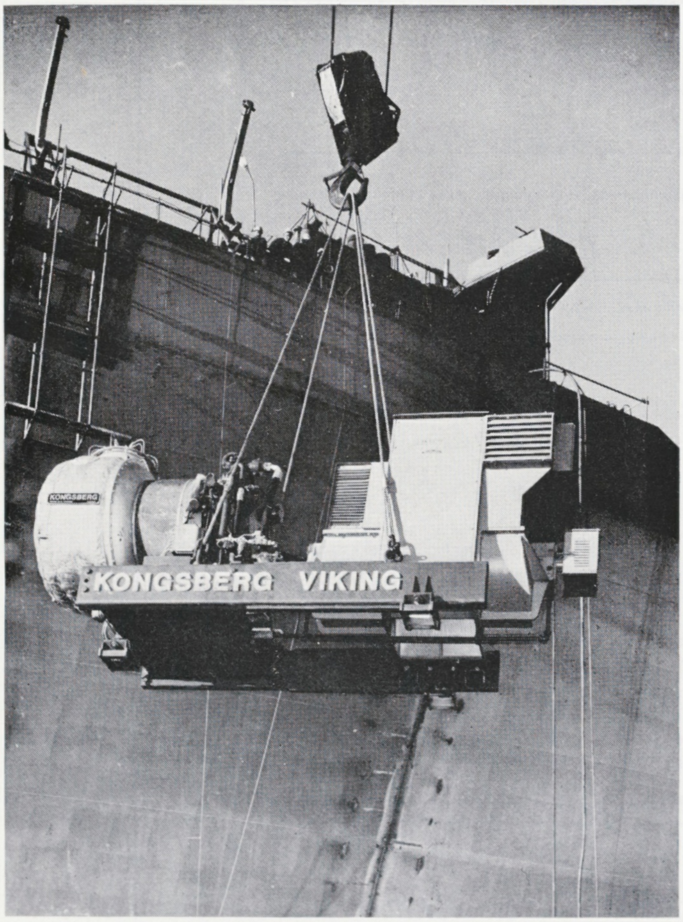


PLATE 12.1

Gas turbine generating set being hoisted on board a 230 000 dwt. tanker.

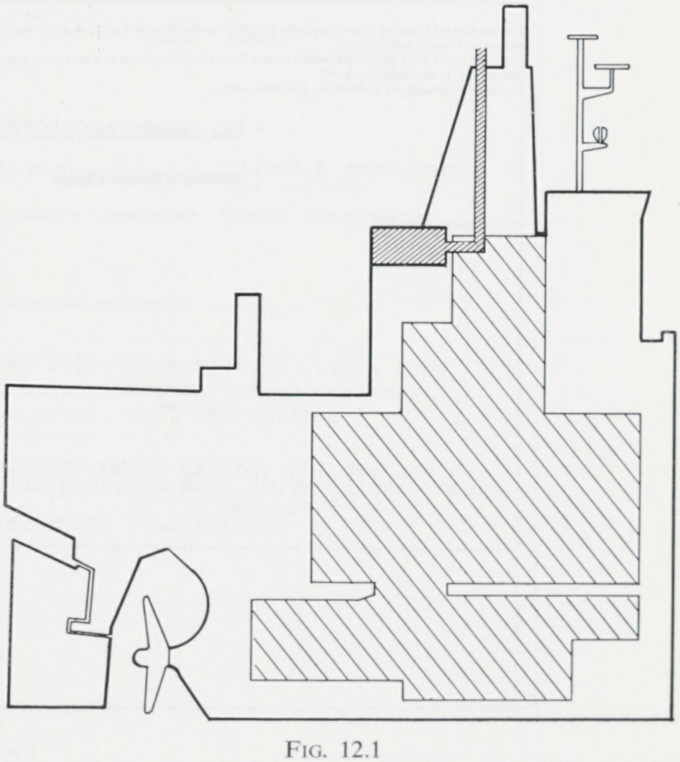


FIG. 12.1

emergency source of power, as required in M 111, there would be no objection to the auto-shutdown of the alternator on high cooling water temperature or low lubricating oil pressure. Alternatively, if the alternator is intended to meet the requirements of M 111, auto-shutdown devices are acceptable, but they should be preferably automatically overridden when the generator is in service as the emergency source of power (e.g. when being used as a harbour generator or stand-by main alternator, the closure of the relevant circuit breakers may bring the automatic shutdowns into circuit). As can be imagined the turbine makers will not allow their system to be free of a lubricating oil failure shutdown and as such it does not meet the present rule requirement of M 111, although to date there are no enforceable rules covering the overrides suggested and are only recommendations as to procedure. Various compromises have been discussed between manufacturers, builders, owners and the various classification societies involved. Part of the proposals are that the high water temperature shutdown has two sensing steps. An alarm at high or unusual water temperature conditions. A further alarm virtually at boiling point of the water and finally shutdown. For low lubricating oil pressure., once again two-step alarms. The first at low lubricating oil pressure, the second a degree lower and a shutdown at seizure point. The step settings are purely theoretical.

Fig. 12.2 shows a suggested arrangement for the automatic shutdowns to be overridden mechanically whilst the alternator is in the harbour or stand-by condition in port. In some

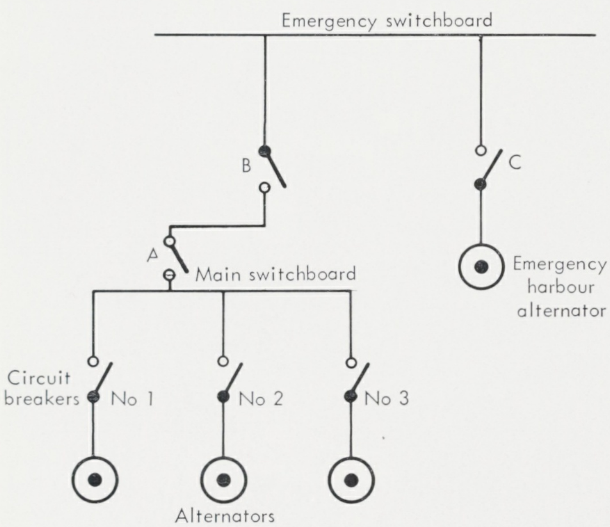


FIG. 12.2

instances the emergency generator and the main alternator can be synchronised and run in parallel.

In harbour service the emergency alternator feed must be opposite to the normal flow and therefore interlocks between B and C must be overridden, e.g. a hand operated switch. Across this switch the automatic shutdown circuitry could be connected so that auto shutdowns are connected during harbour service, but not during emergency service. A question often arises in which the owners request to be allowed to omit one generating unit if the gas turbo-alternator can function and feed back onto the main bus-bars. However, M 403 must still be complied with concerning the number of units to be available.

The testing of this emergency unit if only for emergency or abandon ship purposes, could be rather sketchy. Engines developing 300 bhp and over must have an overspeed trip (H 607) operating at 10–15 per cent above normal speed and shown to work satisfactorily (H 936).

However, full testing of all items, as with main alternators for auxiliary power, should be carried out, i.e. C 910 and Section 9 Chapter C of The Special Survey Requirements. The Section H 6 may also be applicable if the alternator is intended for services other than emergency only (e.g. H 606). The first starting arrangements (H 608) may be incorporated in the system and the relief valve of the hand swung air compressor, or air reservoir, should be seen to function at not more than 100 per cent of the normal working pressure (H 609). The governor of the alternating current turbine driven plant should be set with 5 per cent of full load (M 402).

The starting capacity of the air reservoir with the gas turbine should give at least five consecutive starts from a stationary position without pre-warming through the automatic start being restricted to one attempt.

In general, the examinations further to those enumerated consist of checking the exhaust outlet positioning to ensure that exhaust gases from the unit cannot be sucked into the compressor air inlet (H 908). The means of preventing salt and deposits on the compressor and turbine blades in the marine environment should be examined (H 909). Any battery locker that is in the vicinity should have good ventilation although invariably it is very poor in the initial layouts submitted. Many yards are not aware that F.L.P. light fittings are not available for hydrogen—the gas evolved in battery rooms. In general, battery room lights are always a problem due to possible contact with battery propagated gases.

Plate 12.2 shows the model indicating the emergency generator room out of the way and well above the boiler and forced draught fans. The exhaust piping runs with the diesel generator exhaust line and boiler uptakes through the funnel. The model is invaluable regarding construction problems.

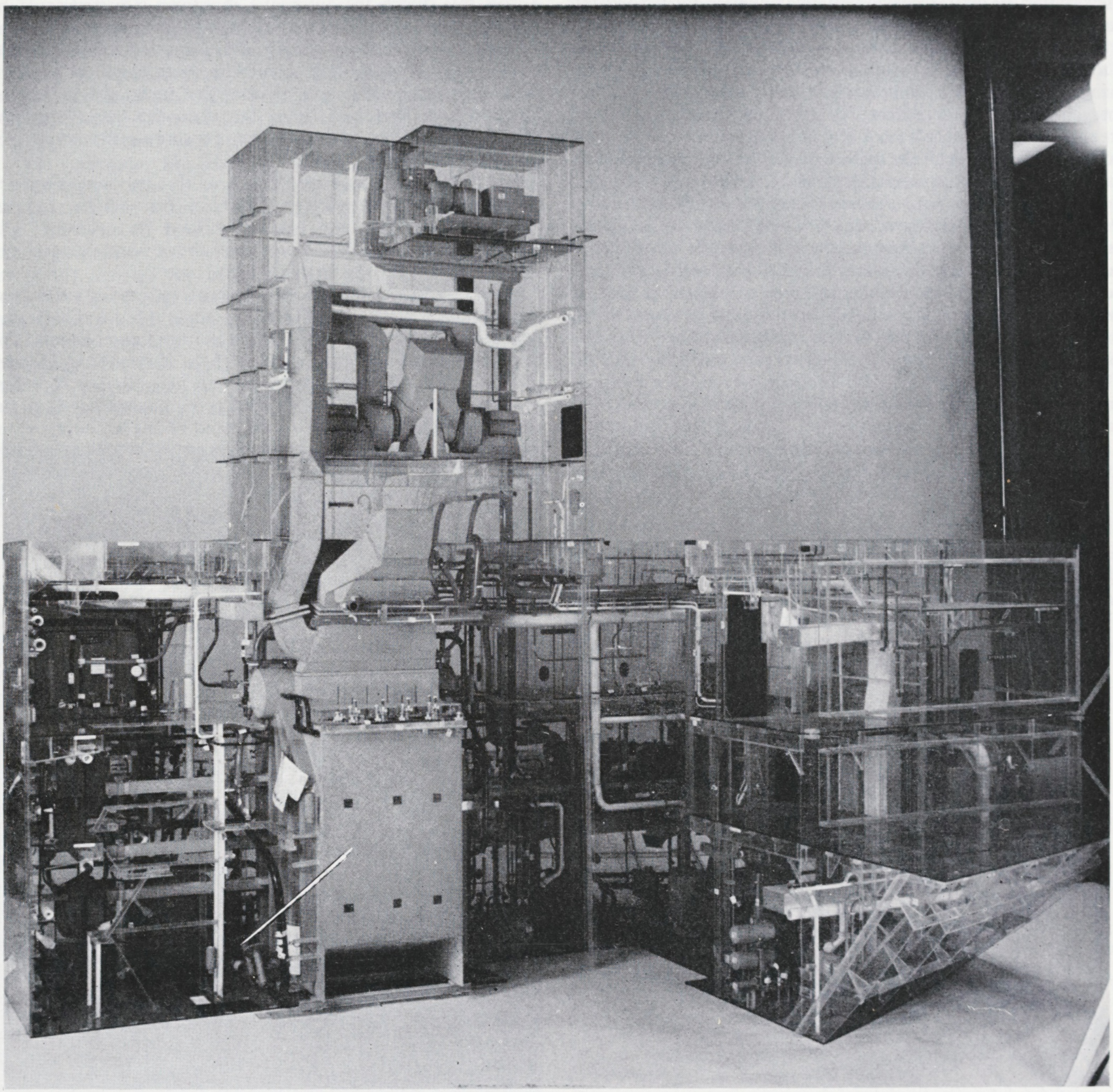


PLATE 12.2

Upper levels of engine room and accommodation showing the emergency source of abandon ship power in the uppermost regions of the accommodation.

13. Pump Room—Deck—Fore Peak

Pump Room

During the outfitting of machinery spaces there is normally left open an access between engine room and aft situated pump room at either port or starboard lower corner. A closing plate is fitted as sea trials approach and it is wise to carry out as many inspections as possible before this plate is inserted. The ladders from pump room top to bottom are nearly vertical and incorporate few resting places. Although going down might not be too bad, coming up could well put one's heart in jeopardy. This has obviously been in the minds of one or two leading tanker companies as they have installed for their staff hydraulically operated elevators in the pump room space. The basic pumps in the lower areas are for cargo, ballast and stripping. The prime movers of the former are situated in the engine room and are connected by drive shafts on universal joints passing through gas-tight glands. Stripping pumps are normally of the steam reciprocating type. There is a section in the Rules that states the pump room must be flooded to a suitable depth prior to launch (D 5204), but the yard would look aghast if this was recommended. Machinery is fitted in the section assembly halls and would not take kindly to a water test (although L 80 (iii) says it must be capable of working when flooded). All pipes, sea water heaters for tank washing purposes, ladders and other fittings should be securely fastened to the structure (D 4015) with special reference to the oil tank boundary bulkhead, as welding here at a later date necessitates gas freeing of the adjacent oil tanks. There are normally bilge suctions situated at port and starboard sides and these can have hydraulic actuators in addition to hand controls. The mudboxes of these valves should be accessible and at platform level as stated in the system section entitled BILGES. Arrangements are sometimes made to have standard S.D.N.R. valves at each side and a central hydraulic isolating valve. The two outer valves remain open and the hydraulic valve is operated as required. This can be dangerous if the ship has a list, as air intake from the higher of the two valves will prevent suction being achieved until it is covered with water. This may require many tons which aggravates the listing effect. Any hydraulic system should include safety features such as in L 801: (i) failure of actuator power in the power-pack room should not permit a valve to open inadvertently, (ii) indication of the bilge valve positions for open and closed position should be fitted and tested, (iii) equipment should be capable of working with the space flooded, (iv) a secondary means of operating the valves, which may be manual control, is to be provided (reach rods halfway up the pump room), and (v) the valves are to be fitted with nameplates (E 250). The cargo handling panels in the power-pack control room have intrinsically safe equipment besides power cables. These cables are not to be close to each other as for other intrinsically safe circuits.

Concerning the electrical equipment in the pump room space. No electrical equipment or wiring, other than that certified as intrinsically safe in respect of the gases and vapours involved is to be installed in any space where flammable or explosive vapour may normally be expected to accumulate such as in cargo pump rooms (M 1603). The intrinsically safe equipment (which doesn't have enough power to cause a spark) is to be physically separated from other circuits (M 1617). This not only applies when the cable is in dangerous spaces but to the whole run of cable in the case of telephones connecting bridge, fore peak space, pump room, engine room, control room and steering gear, the grouping of wires up to the bridge should be specially examined as this aft house trunk is the nerve centre of electrical supplies. The sketch (Fig. 13.1) shows how, when intrinsically safe wiring was too close to other power wiring in this area, a fault gave 220 volts to the pump room phone, together with the places enumerated above. Fire extinguishing arrangement and alarms should be proved satisfactory.

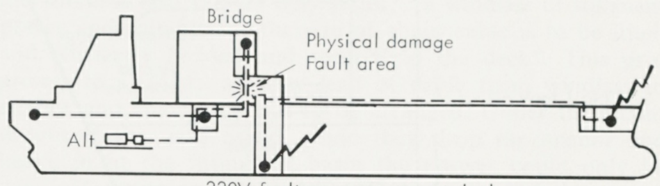


Fig. 13.1

Deck

The decks of large tankers are becoming more littered as time progresses. The usual lines one might be required to test are steam and return for the mooring winches and windlass, foam, fire[1] and deckwash lines and cargo lines to midlength. In the near future will come inert gas piping. Of special reference are liquid CO_2 filling lines, if such a system is fitted, and electrical cable carrying pipes. All the cables on deck are to be away from steam and exhaust lines (M 1615) except mineral insulated and copper sheathed types. At bulkheads a specified distance of 450 mm and 300 mm for pipes above and below 75 mm diameter is recommended as at that distance they should be away from steam pipe-flanges. These cables are to be protected against mechanical damage (M 1614) usually by a galvanised pipe covering. The amount of cable squashed into the pipe must not take up more than 30 per cent of the internal cross-sectional area. Any cable expansion bends in pipes or tray system on deck should be carefully examined regarding clamping, chaffing and separation of cables. The internal galvanisation of such pipes can be rough at times and so tear the cable covering. This pipe system should be drained and ventilated if possible, although vent holes allow ingress of sea water under fully loaded wetship conditions.

Most crews ask if wandering leads are allowed on deck, possibly with the idea of using them in tanks. If they are not used within 3 m of gas outlets [2] or in dangerous spaces there does not seem to be any reason why they should not be allowed (M 1610). This paragraph specifies that lamps other than self-contained battery-fed or equivalent lamps of a certified type in respect of the gases and vapour involved are not to be used in these spaces designated dangerous (M 1603)[3]. Forward on the deck a windlass should be fitted (D 3423) and chocking and alignment is normally checked and approved.

[1] Make sure the fire line isolating valve connecting the engine room pump to the fore peak pump is outside the engine room space as a fire or pipe breakage down below will be impossible to isolate and so give deckline pressure, if it is not situated just forward of the pump room.

[2] M 1603 states intrinsically safe for the deck 3 m rule yet M 1606 says flameproof.

[3] The whole deck of a V.L.C.C. should be specified as a dangerous space. Observe the radio aerial (from aft to a samson post on the fore deck) on a still, damp evening, when the radio operator is sending messages, and see the high tension sparks dancing down the wire. With gas from the tank outlets being ejected so high with the new outlet pressure valve devices, they will understand the concern and reason for making such a statement.

The satisfactory run of cable (D 3424) can be seen when the windlass is operated on sea trial. Most cargo valves are hydraulically operated and monitored from a central cargo control room and the arrangements should comply with L 801 concerning ability to operate the valves by hand should failure of the hydraulic equipment occur.

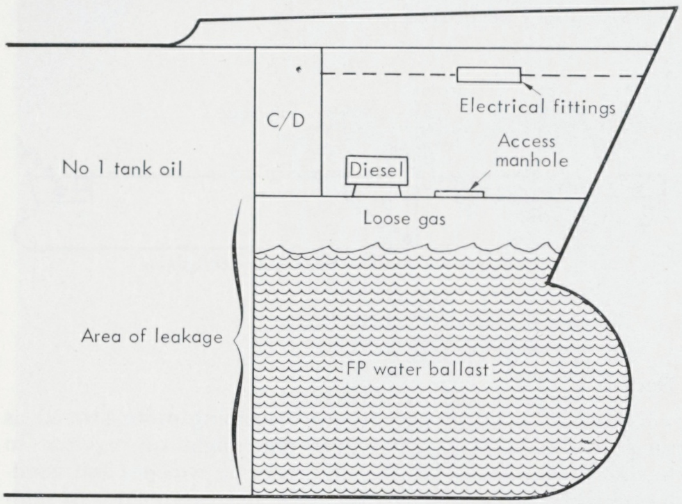


FIG. 13.2

Fore Peak

The fore peak space generally contains a diesel generator as the prime mover for a hydraulic power-pack fire pump unit. This diesel requires a diesel oil fuel header tank which should have the usual remote shut-off on the fuel outlet side. The gauge glass is to be fireproof and well protected and the air pipe on deck to have a non-ferrous gauze fitted. The exhaust from the diesel can cause problems concerning location, cooling and spark arrestor fitting. The engine can be battery, air or hydraulic accumulator started, with local and remote starting. In the case of battery starting, the batteries are to be located as close as practicable to the engine (M 1302) and well ventilated (M 1306). The positioning of any charging devices should be such that the drip proof effect is not impaired, i.e. not mounted at an angle or upside down. This equipment forward has been causing some concern, possibly due to D 4010 which states that where a compartment such as a fore peak tank forms the forward cofferdam, access is to be from the open deck. Diesel or electrically driven pumps should not be sited in the space containing the access. Continuing with M 1604, in enclosed spaces immediately above cargo a tank crowns, lighting fittings only are to be installed and they are to be of a flameproof type.

Fig. 13.2 shows the fore peak section and the possibility of a leaking bulkhead allowing gases and oil to accumulate above any loose water. When the access manhole is opened into the fore peak space and the diesel is running there may be a risk of gas combustion taking place.

The forward echo sounder equipment should be enclosed and the wiring in galvanised pipes, without drain holes (M 1607). The batteries forward can be subject to very low and high temperatures, e.g. −20°C winter and +45°C in summer. It is difficult therefore to conform to M 1615 although a steam radiator in the area can help in the former instance.

Finally, bilge pumping should be checked in the fore peak space, cofferdam and chain lockers with fire extinguishing arrangements examined throughout especially by the paint store lockers.

14. Quay Trials

The purpose of the outfitting Quay Trials are mainly to verify that manufacturers' test specifications as witnessed in the workshops will hold up under conditions of service within the shipyard piping or electrical layouts. In some instances the manufacturers of a component or system use the ship as a test rig due to lack of facilities in their own workshops. It is safer to provide facilities for testing at the quayside with the ship safely moored than to chance commencing a sea trial with unproved arrangements. The schedule concludes with a spin test in which the propeller shaft is unconnected to the intermediate shaft. The turbines are run up to the maximum designed speed plus not more than 10–15 per cent of this value (H 828) when the H.P. and L.P. turbine trips should operate. Sailing crews prefer the upper limit to obviate unnecessary shutdowns due to propeller race under light ballast conditions.

The hand trip at the manœuvring valves (H 829) is tested and then low lubricating oil shutdowns (H 830). The astern valve must not be part of the blocking system and the ability to breath in astern breaking steam should be proved. On completion of these items the main governor is adjusted to a maximum of 2 rpm above the design value. It is important that the steam inlet valve lap and lead is such that the speed does not drop too low before re-injection of steam. The hunting effect of the governor is best witnessed on the steam gauge at the manœuvring valves themselves. The low vacuum cut-out has superseded the sentinel valve (H 833) and this can be tested by breaking the pipe union before the pressurestat. After this spin test, the intermediate shaft is coupled to the propeller shaft, and a few hours run at half speed is carried out. Bearing and tail shaft oil gland temperatures should be noted and found satisfactory. Bilge pumping is ideal at this time due to cleanliness of tank tops as previously stated. Navigation lights can be operated from (i) emergency and then (ii) main switchboard sources (M 505) including their alarms. On completion the ship should be ready to proceed to the trials area.

These pre-sea trial tests are usually very carefully phased and implemented, commencing approximately two weeks before trial date. As such a Surveyor-relay ought to be available to cover the work conscientiously as the programme progresses. This is a far cry from the days when one was asked "What time can you be there".

The finesse which the flow of tests have attained leaves very narrow limits of deviation from the programme during this period. Classification Surveyors requirements should have discussion time allotted to the subject well before things begin to happen. Once the yard have these requirements and devise a programme to include the items, all possible help should be given to adhere and not deviate from the flow chart paths.

15. Sea Trials

"The three most useless things to have on sea trials are umbrella stands, garden shears and Classification Surveyors". These harsh words of wisdom were "voiced" by a visiting superintendent during one of his more frustrated moments. Fortunately, this particular ship was not to L.R. Class. The Surveyor being castigated could have replied that, the secret of enjoying a sea trial is not to go on it. The halcyon days of

12 hours outward and 12 hours homeward, that more mature colleagues are wont to reminisce over seem to have disappeared. Trial times can be anything from one week to one month. With the mulitude of trial participants working an eight hour, three shifts per day system. The Surveyor on call, at times feels as though life has speeded up 300 per cent. As an ex-seagoing engineer as many other colleagues have been, one would imagine the sea routine of more youthful days could be picked up relatively easily. One's brain could be shifted into neutral for a while and the role of armchair critic adopted due to the subconscious soaking up of sea lore, and marine knowledge over the years. Discussions with colleagues appear to thoroughly disprove this premise. When trials of a new ship begin there is a feeling of restrained drama on board. This progresses through nervous anxiety as delivery date approaches to grateful exhaustion if the harsh lights of publicity have not been projected on the ship, due to breakdowns or other newsworthy items. Whatever the feelings one may have about sea trials, they are here to stay according to various sections of rule requirements. One could open with B 301, which states that on satisfactory completion of trials an appropriate class notation will be assigned in the Register Book, thus, LMC (Lloyd's Machinery Certificate). Progressing to G 101, one finds out who shall represent the Society on trials and why (H 840 and H 312 state for how long): viz. "The machinery is to be tested under full working conditions by the Society's Engineer Surveyors, who will furnish a report to the Committee. If found satisfactory, the Committee will grant a certificate indicating that the machinery, boilers and pressure vessels are certified to have been in good order and safe working condition on that date".

Shown is a typical sea trial programme listing the bare essentials to be tested. There is, of course, retesting of items rejected during building pre-trials progressing and these are woven in and around this basic structure.

Item 3,05 covers the rule requirements G 101 concerning full working conditions as the machinery should be fully adjusted and in good working order by this time.

G 107 states that the Surveyors are to test the machinery under full power working conditions and H 312 referring to a full power sea trial. However, in H 840 it only states that sea trials are to be of sufficient duration to prove the machinery under power and normal manœuvring conditions. This is not always interpreted by the builders as the horse power for which the machinery is to be classed, viz. the total maximum approved design shp.

The power is normally verified by reference to tachometer and torsionmeter at normal service draft. Sometimes the engines are only run at the maximum approved rpm over the measured mile. Thereafter the main engines are operated at maximum service speed which can only be 90–95 per cent of design. On the Rpt. 4 the date and duration of the "full power sea trials" are asked for and if only the time for which the maximum rpm had been attained, viz. measured mile, is stated, the question of minimum acceptable time arises and causes discussion.

H 840 astern is for 15 minutes minimum. H 839 states 30 minutes minimum. H 312 states: "Prior to 'full power' sea trials, the teeth of pinions and wheels are to be thinly coated with copper sulphate or equivalent marking". The sea trials are to be of sufficient duration to prove the gears and on conclusion they are to be opened up. The item 2,03 on the trial sheet has then been covered together with the final examination after full power trials. The reason for the early gear examination after running in between 75–81 per cent is that minor gear problems propagate rapidly and can then steady down for the rest of the ship's life. It is therefore thought better to examine at a time which might appear to be too early, than too late.

Returning once more to the programme, one sees at 2,07 the windlass test. D 3423 only states: "a windlass of sufficient power and suitable for the size of chain cable is to be fitted and efficiently bedded and secured to the deck". This progresses to D 3424: an easy lead of cable from windlass to anchor and chain locker is to be arranged. Under these conditions if the yard asked, could they drop the anchor and heave in at the fitting-out basin the answer could only be "yes". However, owners' specifications usually include a water depth (as do one or two other Classification Society's Rules) and lengths of cable to be paid out and hove in.

Item 3,04 concerning the Steering Gear test—ahead, is specified by D 2302 and asks that the power operated main steering gear is to be capable of (i) putting the rudder over from 35° on one side to 35° on the other side with the ship running ahead at a maximum service speed. (Light ship or fully loaded is not indicated, but one should assume and request fully loaded.) (ii) To be capable of putting the rudder over from 35° on either side to 30° on the other side in less than 28 seconds at maximum service speed (and draft).

An auxiliary gear (D 2303) of adequate strength and sufficient to steer the ship at navigable speed, that is capable of being brought speedily into action in an emergency is normally fitted generally of a hand hydraulic type. Although the steering gear will swing over in the allotted time it could be heavily contaminated with air on the hydraulic oil side. In this case, irrespective of time achieved, the test should be rejected.

Finally, H 837 which states "Ships intended for unrestricted service fitted with steam turbines and having a single main water tube boiler are to be provided with means to ensure emergency propulsion in the event of failure of the main boiler. (Instructions to Surveyors 3b 6(a) and G 103 define a main boiler as that which can supply steam to the main propulsion machinery and the auxiliary as that which cannot. A one-and-a-half boiler V.L.C.C. interim usually states main and auxiliary when the auxiliary can and does at times, supply steam to the turbine such as in this instance.) This test is witnessed at point 5,09 on the trial programme. In point 4,01 is included a crash stop—full astern for owners only. The destruction of new articles of plant and boiler uptakes due to vibrations set up at this test point are such that it is the Author's personal opinion this should be eliminated. In these days of advanced radar warning systems this condition may never happen in the ship's life and the damage incurred in relation to the importance of the function is unrealistic.

In conclusion it must be said that sea trials are undoubtedly the most fascinating part of newbuilding surveying and a book could be written about machinery failures, problems and remedies during sea trials.

An excellent book to have on trials is "Code of Manœuvring, Special Trials & Tests" by the Society of Naval Architects & Marine Engineers, New York.

YARD.................................. No.....................

Persons representing the owners and Classification Society, mentioned on this list are entitled to sign for acceptance of the test on which they are mentioned.

Persons mentioned from the yard are responsible for the necessary arrangements and performance of the various tests for which they are mentioned.

Item No.	Test according to Sea Trial Programme	Owners		Class		Yard
		Name	Accept	Name	Accept	
1,01	Zero-Setting of Torsiometer	CL			—	PØ
1,04	Adjustment and Control of Main Engine	JJK/HU		DH	OK	HPN/HMK
1,05	Adjustment of Whessoe Gauges	ACP			—	BT
1,07	Hydrostatic Test of Fore Peak	AG		DN	—	HRA
1,09	Running-in of Main Engine 65/75%	JJK		DH	OK	HMK
2,01	Running-in of Main Engine 75/81%	JJK		DH	OK	HMK
2,02	Adjustment of Scoop	HU		DH	OK	CL
2,03	Stop for Gear Inspection	ACP		DH	OK	HMK
2,05	Hydrostatic Test of CT. No. 2	AG		DN	OK	ODØ/HRA
2,07	Windlass Test	PO		DH/DN	OK	AWD
2,08	Running-in of Main Engine 81/86%	JJK		DH	OK	HMK
3,01	Adjustment of Bridge Control	HU		DH	OK	OTP
3,02	Zero-Setting of Torsiometer	CL				PØ
3,04	Ahead Steering Gear Test	ACP		DH/DN	OK	AWD
3,05	Fuel Consumption Run	JJK				HPN
3,06	One Double Run (Decca Readings)	OL				BT
4,01	Special Tests	JJK		DH	OK	AWD
4,01	Good Function Test	JJK		DH	OK	AWD
4,02	Zero-Setting of Torsiometer	CL				PØ
5,01	Two Boilers in parallel	JJK				HPN
5,02	Tank Cleaning Test	PO		DN	—	AWD
5,03	Stripping Eductor Test	PO				HRA
5,04	Scoop Test	HU		DH	OK	GLa
5,06	Cargo and Ballast Pumping	PO		DN	OK	AWD
5,07	Stripping Pump Test	PO				HRA
5,09	Emergency Steaming Trial	JJK		DH	OK	HPN
6,02	Adjustment of Wireless Direction F.	OL				AWD

FIG. 15.1

16. Post Sea Trials

At this port it is impossible for the newbuilding to return to the shipyard due to lack of water depth. However, as the trial draws to a close and the ship anchors at a pre-arranged handing-over position, the majority of participants leave for home. All memories of earnest and profound technical discussions are conveniently forgotten in case they delay their exodus. Among the exhausted few left on board is, of course, "Lloyd's". The purpose of this being to examine, in conjunction with owners, various items as they are opened up. These post sea trial examinations are dwindling rapidly in quantity as charter dates become closer to pre-arranged delivery dates. At the moment the items opened up are: —

(i) Boilers on water and fire side.

(ii) Lubricating oil filters.

(iii) Condensate filters.

(iv) Sea Water filters.

(v) H.P. turbine thrust and forward bearing.

(vi) L.P. claw coupling.

(vii) Gearing casing inspection doors and a cover of one of the epicyclics.

The final item being an L.R. rule requirement, the former items are purely owner's, although we are asked to give an opinion. These basics are supplemented by any automation equipment or otherwise that has not functioned correctly during trials to the Surveyor's satisfaction. In passing it may be mentioned that an internal examination of a modern water tube boiler is nearly impossible without removing the internals and neither owners or yard wish to do this at this time.

Although in days gone by it could be said that Lloyd's meant ships and ships meant Lloyd's, today it is not so much the case, and when pressing for any of the items enumerated to be examined for general interest only, it is well to remember that ships are built for shipowners to make money and not to keep Surveyors occupied.

Dependent on whether the trial has been according to the scheduled one week and reasonably successful or one month and a shambles, the examinations progress rapidly or lethargically. The gearing should show a minimum bearing surface of 70–90 per cent of the face width with contact over the involute profile. This is very difficult to see as any initial marking compound that has been applied tends to disappear or become one useless smear dependent on the additives on the lubricating oil. A torch with new batteries and clean glass is usually sufficient to see whether the teeth have been bearing at all. Unless extraordinary trouble is so evident as to be impossible to miss, acceptance is a matter of course.

The boiler safety valves have usually lifted several times during the trial and hammered on their seats, so lowering the blow off point. A resetting of these items is to the sailing engineer's advantage and makes the pressures as typed on the Interim Certificate of Class valid once again. A final check of items related to reports to be sent to London is well worth the time spent and the final date of examination can be entered. This ties up the report except for including expenses involved.

After the gathering on the bridge, at which the yard extol owners and they reiterate with a likewise speech that is a model of the obvious. A glass of champagne is quaffed, shipyard flag unshipped and owner's flag raised to three cheers and everybody makes their various ways home. All that remains for the Surveyor to do is hand in the report for typing then signing, listen to his wife tell him what a wonderful time he's had and then watch the centre pages (casualties) of "Lloyd's List" for six months.

17. Conclusion and Acknowledgement

Initially it was decided to write these notes similar to an Oriental newspaper, knowing most scanners (nobody reads any more) of technical literature start at the rear. However, it was decided to attempt a second course in which it is realised that people are usually kept interested if the context is humorous, interesting or personally aggravating. It is hoped the latter has not been unwittingly the case. It is also hoped that the opening lines have been remembered throughout. The paper is to give the beginner an initial perspective broader than would normally be the case if left to wander through the maze unaided. The paper is not a learned treatise but a series of factual events. As such all written contributions to the discussion, however, small, could fill in detail and be helpful to a colleague somewhere, at some future date. The light it has thrown on this subject may not have been so strong but maybe some of the shadows are no longer so dark.

ACKNOWLEDGEMENTS

1. The Stal-Laval Company for the material made available with special reference to their local representative, Mr. T. Langballe, who verified technical statements concerning their equipment.

2. The Kongsberg Gas Turbine Company for material made available.

3. The Management of Odense Staalskibsværft A/S, Lindø with special reference to: —
   (a) The Production Manager and Staff,
   (b) Mr. Kurt Andersen, Machine Drawing Office Manager and Staff,
   (c) Mr. A. W. Van Dijk and Engineers of the Control Department,
   (d) Mr. R. S. Barr of the Classification Department.

4. Mr. K. Voss of SEMCO Odense A/S.

5. The A. P. Møller Company for allowing material and photographs to be used with special reference to their local Chief Superintendent, Mr. A. C. Poulsen, for technical verifications and amendments.

6. My colleague and good friend K. O. Larsen for his patient and constructive criticisms.

7. Last but not least, my wife for keeping the children at bay for half the time whilst the paper was being written and typing the initial draft for the other half of the time.

REFERENCES

1. Paper No. 3 Session 1970/71 "Fire Detection in Unattended Machinery Spaces", by J. D. Bolding.

2. Paper No. 2 Session 1971/72 "Some Comments on Shafting and Sterntubes", by C. M. Bergmann.

3. Paper No. 3 Session 1971/72 "Marine Steam Turbines—Some Problems Encountered and Future Outlook", by K. M. B. Donald.

4. Paper No. 5 Session 1959/60 "Gearing", by L. Teasdale.

5. Paper No. 3 Session 1959/60 "Pumping and Piping Arrangements", by H. R. Clayton.

6. Paper No. 4 Session 1971/72 "Classed Refrigerated Installations", by P. K. Coles.

7. Instructions to Surveyors—Surveyor's Guidance Notes on Radiography—1967.

8. Paper No. 8 Session 1970/71 "Ships' Electrical Installations and Their Surveys", by Ir. W. de Jong.

9. Paper No. 3 Session 1961/62 "The Survey and Testing of Marine Electrical Equipment", by W. Morris.

10. Paper No. D1 Session 1970/71 "Simplified Short-Circuit Calculations for Marine Alternating Current Networks", by W. Morris and K. H. Klemm.

Lloyd's Register Technical Association

Discussion

on

Mr. D. Hague's Paper

SOME NOTES ON A LARGE TANKER MACHINERY INSTALLATION—STEAM TURBINE

Paper No. 6. Session 1972-73

Hon. Sec. C. Cummins
71, Fenchurch Street, London, EC3M 4BS

LLOYD'S REGISTER TECHNICAL ASSOCIATION

PAPER No. 6 SESSION 1972–73

SOME NOTES ON A LARGE TANKER MACHINERY INSTALLATION STEAM TURBINE

by Douglas Hague

ERRATA

Page 5. Items 3 to 11 of the Aide-Mémoire should read: —

3	Installation of machinery	Rpt. 4 Part 1 Sheet 1
4	Installation of machinery	Rpt. 4 Part 1 Sheet 2
5	Installation of machinery	Rpt. 4 Part 2 Sheet 3
6	Installation of machinery	Rpt. 4 Part 2 Sheet 4
7	Installation of machinery	Rpt. 4 Part 2 Sheet 5c
8	Installation of machinery continuation Sheet 4b (Cons)	
9	Installation of watertube boiler—main	Rpt. 5c (Inst)
10	Installation of watertube boiler—aux	Rpt. 5c (Inst)
11	Installation of st/st generator	Rpt. 5 SGE (Inst)

Page 15. Fig. 6.5 is amended as shown.

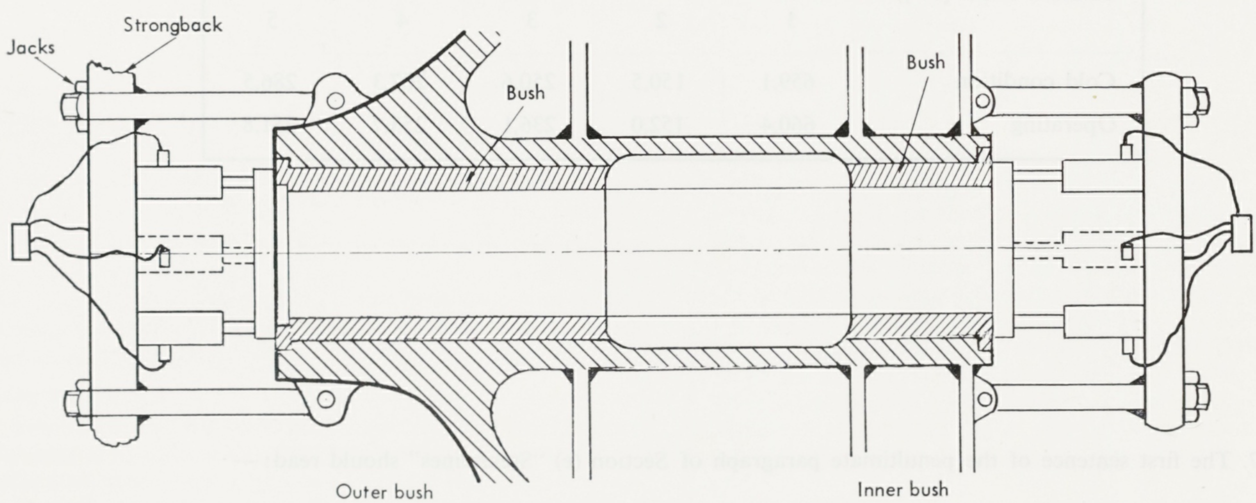


FIG. 6.5

Page 24. Figs. 6.13 and 6.14 are amended as shown.

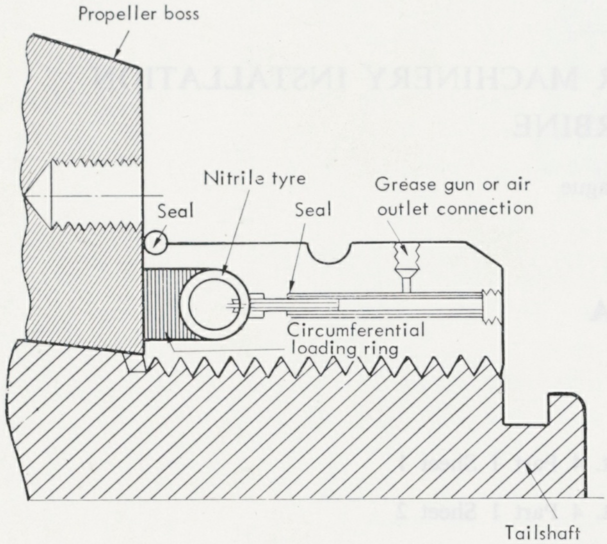


FIG. 6.13

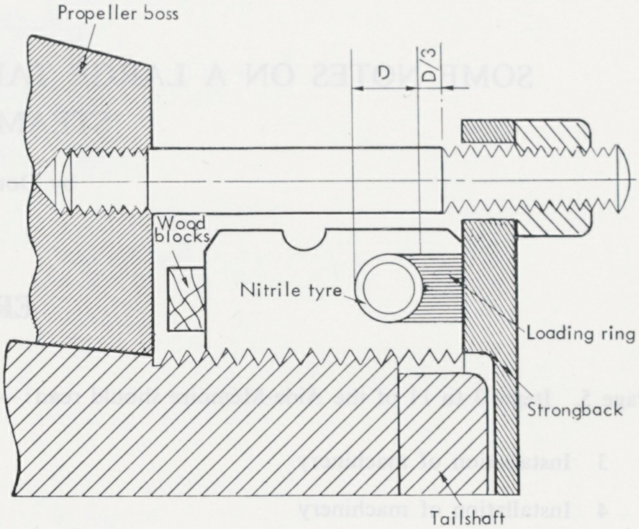


FIG. 6.14

Page 28. The table referred to in the final paragraph was omitted and reads:—

BEARING LOAD (kN)	BEARING NUMBERS				
	1	2	3	4	5
Cold condition	659,1	150,5	250,6	207,3	286,5
Operating	660,4	152,0	236,1	253,7	251,8

Page 57. The first sentence of the penultimate paragraph of Section (e) "Steamlines" should read:—

Care should be taken with the mounting of bellows type expansion pieces in steamlines (E 601).

Page 61. Figs. 10.1 and 10.2 are amended as shown.

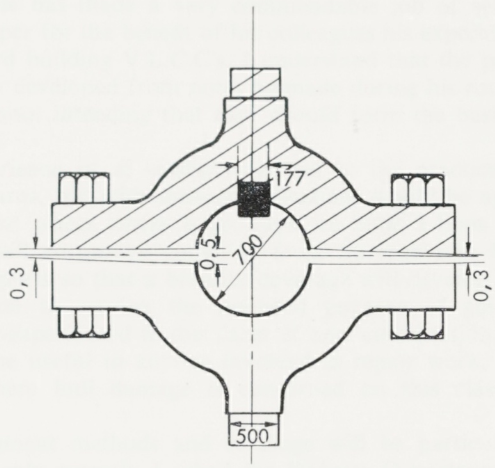


FIG. 10.1

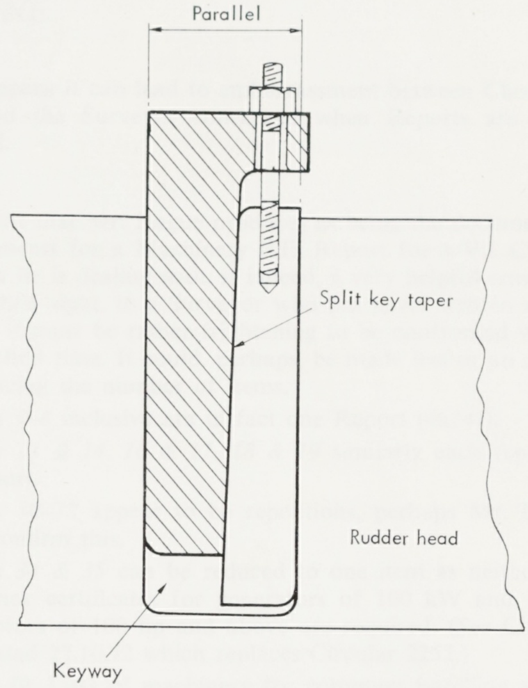
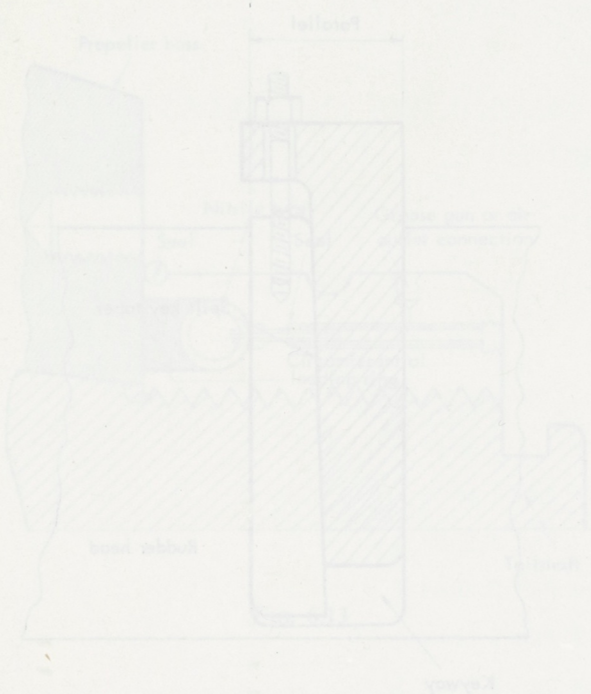


FIG. 10.2

Page 24. Figs. 6.11 and 6.14 are amended as shown.



Page 28. The table referred to in the final paragraph was omitted and reads:—

Bearing Load (kN)	Bearing Numbers				
	1	2	3	4	5
Cold condition	659.1	150.5	250.6	202.3	266.3
Operating	660.4	152.0	256.1	198.5	291.8

Page 57. The first sentence of the penultimate paragraph of Section (c) "Steamlines" should read:—

Care should be taken with the mounting of bellows type expansion pieces in steamlines (B.601).

Discussion on Mr. D. Hague's Paper

SOME NOTES ON A LARGE TANKER MACHINERY INSTALLATION–STEAM TURBINE

Mr. N. CHAMBERS

Mr. Hague has made a very commendable job of setting down on paper for the benefit of his colleagues his experiences in a shipyard building V.L.C.C's. I understand that the paper was actually developed from notes he made during his routine surveys without intending that they should form the basis of a paper.

The experience is, of course, confined to the practices in use in one area, but with some modifications would be applicable to most places where large ships are built. I hope that the paper will encourage comment from Surveyors in H.Q. and the outports so that a broader coverage will develop.

In addition to serving the intended purpose of guiding Surveyors inexperienced in this facet of new construction, the paper will be useful to anyone involved in repair work, particularly where hull damage is concerned on this class of vessel.

The alignment methods and readings will be particularly useful and only recently I asked the Reports Department to arrange for brief details (a copy of the Builder's records will do) to be sent to H.Q. with the F.E. Report. A copy should also be on board ship, but these copies have a habit of disappearing through time. Alignment is very much related to construction of the hull and the stiffer the structure supporting the machinery and shafting the better the chances of maintaining alignment under varying conditions of loading.

The mention of the F.E. Report is a reminder that experience taught me it must be completed (or a draft copy) before the ship leaves the yard. As Mr. Hague suggests, fill in the required information as the work progresses, so that the report is completed on sea trials. I would also agree that walking round the yard noting what is going on is a good practice particularly during the lunch hour.

An essential part of new construction surveys is frequent visits to the drawing office. Friendly discussions at this stage can smooth away many problems!

Going through the paper I marked a number of places for comment but after checking with my colleagues, I have left detailed discussions to the specialists.

Thank you Mr. Hague for an interesting paper.

Mr. R. M. LEACH

I would like to endorse the complementary remarks that Mr. Chambers has made with regard to this excellent paper that Mr. Hague has produced. It has been read with interest in Engine Reports Dept., and there are several points I would like to comment upon:—

Page 3. Section 4

The notations LMC ✠ UMS is probably a printing error. I I assume it should be ✠ LMC, UMS. Whilst dealing with the subject of notations it might be as well to mention "Ice Class" and the Inert Gas System, notation "IG Sys", which also affect the Engineer Surveyor and his reports. It is comparatively easy for the Surveyor to overlook the former and if this happens it can lead to embarrassment between Classification and the Surveyor concerned when Reports are being checked.

Page 5

The list that Mr. Hague produces as being the documentary requirements for a Machinery F.E. Report for a V.L.C.C. of the type he is dealing with, is indeed, a very helpful reminder. But at first sight, to a Surveyor who has never written a F.E. before, it must be rather frightening to be confronted with it for the first time. It could, perhaps, be made less of an ordeal by reducing the number of items.

Items 3–8 inclusive are in fact one Report (4a/4f).

Items 13 & 14, 16 & 17, 18 & 19 similarly each represent one report.

Items 30–32 appear to be repetitions, perhaps Mr. Hague could confirm this.

Items 34 & 35 can be reduced to one item as neither test sheets nor certificates for generators of 100 kW and above and motors of 100 hp and above are required. (*See* Circular 2283 dated 27.10.72 which replaces Circular 2252.)

Item 39. Lists of machinery for computer handling are no longer required, as already mentioned by Mr. Hague, as the information necessary for this procedure is obtained direct from sheets 3, 4 and 5 of the Report 4a/4f, the purpose for which it was designed. I understand Circular 2246 has been, or is about to be cancelled.

Item 40. "As Fitted" plans are only required when major alterations have been made to approved plans and are very seldom submitted now. If major alterations are made during fitting out, Surveyors forward the amended plans for early approval at that time.

Item 36. List of Sea Valves. This requirement is not connected with Circular 2257 but is included in requirements of Circular 2246 now cancelled. Thus it can be seen that a less formidable, though no less useful list could be drawn up consisting of less than 40 items.

Page 21

Regarding the question on Rpt. 4a/4f, Part 1, Sheet 2, which requires the diameter of the propeller cone at large end (or in the body, if the shaft is flanged), to be stated.

Where a shaft is of the type that has a cone connection to the propeller, the diameter of the shaft at the large end of the cone should be stated. Whereas, in the type of shaft that has a flanged connection to the propeller it is necessary to state the diameter of the body of the shaft. The practice adopted by Mr. Hague is, however, to be encouraged as the additional information he supplies could well avoid searching through records at some future date if investigations into the original shaft scantlings were ever found necessary.

Page 22

Report 4a/4f Inst. Part, 1, Sheet 2, "The material and tensile strength of screwshaft are entered under the heading

Tubeshaft as there is no requirement for this information under the heading Screwshaft". This is not strictly correct, although the word *Tubeshaft* is in heavy type on the report, the line below states clearly material of *screw/tube* shaft and the line below that asks for thickness of liner for *screw/tube* shaft. The Reports were designed in this way, in the interests of keeping them as concise as possible.

Page 30

Report 4a/4f, Part 2, Sheet 3, Side 1—Gearing. (Page 36. Fig. 6.32.)

"Thrust—Separate or Integral", this section is designed to supply the necessary information for the computer reporting system. Although the whole section appears to be headed Gearing, the last three items could apply to a non-geared type of installation such as a direct drive diesel, the items in the second column apply to geared installations only, while those headed *Coupling, Shafting* and *Thrust* apply to all installations. It is, therefore, necessary to complete the whole section in the case of an installation of the type under discussion whereas in any non-geared installation only the items under the last three headings need be completed.

Emergency Source of Power, Page 72

Although small emergency generator sets need not be constructed under survey it is expected that those of 100 kW and above will be, and the T.V.C's accordingly submitted. Certainly, large emergency sets which are a third source of power should be constructed under survey and it is in the Owners' interest to see that this is done.

Finally, to young Surveyors making their first attempt at this type of F.E.:—

1. Make sure all the plans as required by the Rules have been submitted and approved. Be sure any alterations made by H.Q. to the plans or instructions in Secretary's letters have been complied with.
2. Be certain T.V.C's for main and auxiliary machinery have been approved.
3. Carefully read all construction reports received from other outports and H.Q. in case any conditions of class have been applied, T.V.C's, crankcase relief devices, overspeed trips, etc.
4. State clearly what the initial starting arrangements are and be sure they comply with Rule requirements.
5. Fig. 9.5. Be sure that the question "Do the pumping arrangements comply with the Rules including special requirements for oil tankers, ships classed for carriage of cargo oil, or classed for Navigation in Ice" is answered.
6. If the ship is classed for Navigation in Ice, the following request "State means provided for clearing ice from ship's side valve" is to be correctly answered.
7. Where accumulation tests have not been carried out, make sure the full requirement for waiving the tests have been complied with and state the date of the Secretary's letter approving the waiving.

Mr. R. F. MUNRO

As one reads through this paper it soon becomes clear that Mr. Hague has not only spent much time studying machinery space models; he has also been clambering about like an extremely inquisitive private eye!

One of the features of the paper is the way in which the reader is lead along various fascinating paths only to be brought abruptly back at intervals to the Author's stated object—and in this way interest is never allowed to flag.

I would like to put a few points to Mr. Hague.

The illustrations of pinion teeth on page 35 indicate that tooth contact in the workshop is distributed about the mid-three-quarters of the combined tooth length, both ahead and astern, and while it is noted that these markings are similar to those obtained on board would the Author care to say whether this indicates the position after full power sea trials. On page 79 it is stated that the initial marking compound becomes so smeared as to be useless for the purpose of determining the extent of tooth contact, and it would be interesting to learn whether any work is being done to develop a more satisfactory coating.

There have been cases of cracking of branch welds in high pressure steam lines believed to be due to an undesirable combination of pipe expansion and restraint of fittings, and I feel that the section on Steam lines on page 57 would be enhanced by the inclusion of some remarks from the Author on the arrangement and support of main and auxiliary steam pipes with particular reference to cold pull-ups.

When reading on page 58 the Author's obvious reluctance to accept fuel tank graphs it occurred to me that it would be a fairly simple matter to calibrate awkwardly shaped tanks by placing a meter in the filling line when preparing for water test, but perhaps the time required would not be tolerated in an extremely tight building schedule.

It is perhaps worth emphasising that self-closing cocks (E 413) when on sounding pipes to oil fuel or lubricating oil tanks are required to have parallel plugs to prevent them from being jammed open, and this should be verified and their free action checked.

The Author is to be congratulated on his energy and application and his valuable paper well merits a place alongside that by P. T. Brown of an earlier generation. A comparison of the two clearly demonstrates how far marine engineering has advanced in the course of these few years.

In conclusion I would simply add that I still have the deepest suspicions about the reason for the engine room lifts being out of action every time I joined the Author on board one of these V.L.C.C.'s!

Mr. R. R. HOLTUM

I should like to thank the Author for this well written and timely paper which will be of considerable value to Surveyors, particularly those freshly engaged on new construction work. Whilst no one can be an expert on everything a Surveyor should not be seen clearly seeking guidance from the yard foreman whose work he is there to check and clichés about using "common sense" and "good engineering practice" are of doubtful validity when faced for the first time with laser beam equipment or fitting a hydraulic propeller nut.

Turning to details in the paper I would encourage the Author in his efforts concerning waiver of the safety valve accumulation tests on board. Most safety valve manufacturers do not possess sufficient steam generating capacity to carry out these tests themselves but it is a distinct advantage if a prototype can be evaluated and certified since with the high temperatures and pressure now used a prolonged blowing can result in the valves needing regrinding and, of course, resetting.

The practice of constructing a model of the engine room is an excellent one. Even the best piping plans are not infallible and there is frequently a scramble among individual pipe erectors for the easiest runs for their particular lines. The modular concept illustrated in Plate 8.1 eliminates this to some extent but not entirely. On the question of steam lines I would ask the Author to comment on the Rule requirement (paragraph E 601) concerning provision for expansion. We have had experience recently of pipe and valve fractures caused almost certainly by the unsuitable location of anchor points and bends. Would the Author agree that the Surveyor should check the yard plans for these fittings and ensure that anchor points are, in fact, placed so as not to cause severe bending stresses in vulnerable valves and pipe connections.

To the Author's comments on gears I would add that where fine-tooth flexible couplings are fitted it is most important to check in the fitting shop the tooth bearing of the two components. Since all the teeth should be touching simultaneously an even bearing on all is not easy to obtain but must be insisted upon.

Whilst agreeing with the Author (page 51) on the necessity for reading and re-reading Chapter E of the Rules I would caution against the danger of too detailed an interpretation of words or phrases in the Rules taken out of context. In paragraph H 608 we require equipment to be provided for the initial development of starting air on board. Whilst I was on plan approval work in Japan many years ago I was asked by a yard now quite prominent whether the word "initial" meant that a portable compressor could be used for filling the air receivers during fitting out and then taken ashore again. I countered that this was not so since the word "provided" meant a permanent installation but can we really insist that the Japanese interpretation was not valid? I have my doubts.

Finally I would take this opportunity of asking Surveyors in building ports to be meticulous in descriptions of engines and boilers, e.g. main engine B & W K.90 GF, boilers Combustion Engineering V2 M-8 or main turbines General Electric MST.14 even when the units are built by licensees. It is essential when analysing trends in defects and damages to know the precise type, model and if possible the serial number.

Mr. J. Crawford

The Author is to be congratulated on a well tabulated and laid out paper. That the paper contains a wealth of knowledge and experience, is obvious from the manner in which it deals with the various stages of installation. There are, however, one or two points on which I would like to comment.

One of the items is the reference on page 41 to the "battery being flat" and apparently no indication of this condition. For my own part I am not too keen on first starting arrangements being dependent on batteries which for one reason or another may be found in the condition indicated.

Further, the time taken to charge the batteries may be excessive. I understand that to charge a "normal" battery may take up to six hours or more to complete depending on the charge required. I know the battery can probably be charged in much less time, but with possible damage to the battery which could lead to a state of go or no go first time starting.

It is considered the time to obtain power for first starting should be in the region of one hour.

Another interesting point was the reference to the first start diesel unit exhaust joining the exhaust from the auxiliary units. Usually the only indication on plans submitted for approval is a small square marked emergency air compressor and, of course, no indication is given of any exhaust pipe.

Reference is made on page 51 to orifice plates, and quotes paragraph RD 114. I am a little doubtful about the use of orifice plates to reduce or regulate flow. Could the Author give any indication of how long they last?

Could the Author also say if the orifice plate is of metallic or non-metallic construction? Where such a plate is fitted, is it in conjunction with a straight length of pipe having a length of, say, 6 dia. fitted down stream of the plate?

I think a reducing piece would be more appropriate. This would also be acceptable to RD 114 which indicates that protrusions in pipes should be avoided.

The reference to the use of stainless steels in the construction of shipside valves is very appropriate. It is the usual procedure when dealing with approval of plans for such valves to draw attention to the use of this material in such fittings.

Reference is also made to Circular 2257 regarding the construction of butterfly valves and it may be well to mention that whilst reference is made to certain types of valves which have given unsatisfactory service in certain cases, this does not automatically preclude valves incorporating such features from being accepted, each type being judged on merit of strength, construction and satisfactory service.

It is concluded the reference to forepeak valves being NOT attached to the collision bulkhead should read, "verify that the valve is attached to the collision bulkhead".

On page 55 the Author draws attention to the test pressure of boiler feed pipes as twice that of the design pressure. It is concluded this refers to the design pressure of the pipes which should be $1\frac{1}{4} \times$ design pressure of the boiler, or maximum discharge pressure of the feed system. Further, the Author's reference to J.523h should read E.511b.

It is agreed that the capacity of the distiller/evaporator is usually accepted when the requirement of the sea connection to the feed pump is waived.

Concerning the restriction of bronze and cast iron valves and fittings in steam systems, it may be well to add that the restriction to the use of these materials as per paragraph E 605 was intended to restrict the use of bronze castings of uncontrolled quality to low pressure steam systems. It was not the intention to prevent any firms using bronze castings for higher pressure provided the material is of suitable composition, tensile strength, and ductility which has been approved by the Society.

In this respect it may be worth mentioning that bronze castings of approved quality have been accepted for use in steam systems for conditions of 218°C 21,5 kg/cm^2. Similarly S.G. iron of approved quality has also been accepted for use in steam systems, *other than boiler mountings,* for these working conditions. Bellows pieces are not recommended in steam systems due to eddying in steam flow and possible high frequency vibrations in the convolutions. Where such units are fitted they should be provided with internal shields. Further, the bellows should be provided with protection against mechanical damage in addition to provision being made against over extension/compression. The bellows should not be used to compensate for any misalignment of the piping system.

It is agreed that the oil fuel system should be tested to $2 \times$ W.P. after installation on board. However, this does bring one aspect to mind which the Author may be able to sort out

for me. The Rules require the thickness of piping for oil systems to include constant C of 1,4 to give additional thickness in order to withstand the test pressure of 2 × W.P. The Rules for pressure vessels, however, does not include this extra provision and I would be pleased if the Author could enlighten me as to how this complies with paragraph E 512 of the Rules which require pipe systems to be tested to 2 × W.P., e.g. does the Author include or exclude such items as heater or filters when supervising the above test?

The Author on page 58 refers to "dip sticks" for sounding oil tanks, this may be just a local termology, but my understanding is that "dip sticks" would only be considered for use in independent open tray drain tanks or purifier sludge tanks.

I was pleased to see that when reference was made to a paragraph of the Rules it included some indication of the requirement. The indication on its own of "requirements of paragraphs 1, 2, 3, etc., to be complied with" is not to be recommended, since due to the continuing addition and amendments to the Rules any particular rule number may have no connection to the requirement intended.

Mr. J. D. BOLDING

The Author states in his introduction that he has deliberately introduced some controversial views and questions to stimulate discussion. This is certainly true for Section 11 dealing with Control Equipment. It is sad after over five years of widespread application of control systems to ships that some shipyards and owners have learned so little.

Control equipment will only operate satisfactorily on ships when the builders and owners accept the need to establish clean conditions in the control room prior to installation of consoles, and allocate time to allow proper commissioning of the system with only the test team present.

The Author states this routine is not being carried out for economic reasons. It is not surprising that he has some sad tales to relate. The economics of such a routine is surely clear with such evidence.

Oil and water contamination of control air pipe lines are also blamed for control system failures, in spite of the provision of dryers and separators. Could the Author give further details of this problem? When approving control air system plans it is customary to recommend duplicate air dryers and filters. It is considered that this recommendation should be introduced in the Rules.

Regarding electronic equipment, the failures described such as voltage surges affecting transistorized components and repeated calibration of equipment due to drift can be attributed directly to bad design.

The shipping industry must come to terms with electronic equipment. It is suggested that within the next decade, governors of most internal combustion engines will utilize digital electronic techniques. Such equipment will be cheaper and easier to manufacture than the hydraulic governors commonly used on marine diesel engines.

The centralized computer will replace the anologue electronic and pneumatic controls and relay based alarm systems currently in use.

Does the Author consider that surveying the installation and testing of such equipment is a task which an engineer trained in heavy engineering can undertake? It is suggested that the survey of such control equipment requires specialized personnel. Short courses in control theory and electronics will surely not suffice in these circumstances.

The Author mentions checking the location of fire detectors in machinery spaces at the model stage. What method is used to confirm the siting of detectors at the trials stage of vessels building in Denmark?

Mr. P. MANSON (Newcastle)

I would like to congratulate Mr. Hague on his paper which contains considerable and valuable information for the Outport Surveyor especially those concerned with new construction.

I have a few points which I would like to raise, and to refer also to the historical development of the Steam Turbine.

Turbinia

The first trials of the *Turbinia* were held in November 1894, the top speed reached was a disappointing 19¾ knots. The fault apparently lay in the design of the propeller, the turbine having performed perfectly well. The propeller problem was due to cavitation. Experiments on the design of the propeller were carried out as a result, and evidence of the number of propellers used for this can be seen by those who are interested in the Museum of Science and Engineering in the Exhibition Park, Newcastle upon Tyne, where there is a formidable display of the different designs of propeller which were produced, before a final design was decided upon. The actual *Turbinia,* of course, is also on display.

During the course of experiments on the propeller design it was decided to replace the original propeller shaft and turbine with three shafts driven by three turbines. The high pressure parallel flow turbine was fitted to the starboard shaft, the intermediate to the port shaft and the low pressure to the centre shaft, which also had a small astern turbine. The original boiler was retained, but was altered from induced draught to forced draught. It was in February 1896, when new trials were carried out, that it was immediately apparent that the meticulous research into propeller design had not been in vain.

As a result of her success the Admiralty ordered the turbine powered destroyer H.M.S. *Viper* in 1898. The first commercial ship was the famous Clyde passenger steamer *King Edward* built in 1901 which gave good service until she was scrapped in 1952.

Fitting of the inner and outer sternbushes (page 15)

In some yards the welding of lugs to the sternframe for the purpose referred to, is not considered to be good practice on account of the possibility of cracks developing. The oil jack method is employed using a strong pull up bar instead of welding lugs to the sternframe.

Could the Author please indicate the type of coating applied to the bush surface before force fitting. Trouble has been experienced where a "molycote" base coating has been due to the molycote having been left in spaces difficult to clean and subsequently getting into the lubricating oil and resulting in an excess weardown rate of the white metal.

In one case where a ship had to withdraw a white metal lined cast iron bush for re-metalling, the bush could not be drawn out and had to be cut out. It was subsequently discovered the bush had been fitted dry and had rusted between the mating surfaces and thus had become one, with the sternframe.

An interference of 0,04 mm with a normal press up of 120 tons and 85 tons respectively is indicated. Could the Author please indicate at what position the 120 tons loading

is recorded for instance at the last 3 to 6 inches of pull up?

On the 300 000 ton class of tankers the calculated pull up is 74 tons which is considered to be adequate, but in saying this, various factors arise such as accuracy of boring, surface finish obtained in bore of sternframe. It would be of interest if information could be obtained on the above facts.

Fitting of the Tailshaft (page 18)

It is interesting to note that oil stub pipes are galvanized, but it is also considered a heavy gauge pipe should be used. Before the fitting of the tailshaft it is also advisable to check the thermometer wiring systems.

After fitting the tailshaft it is also considered prudent to check the tailshaft clearance this being measured at each quarter position with tailshaft free, to prove the alignment of the bushes is correct. If clearances port and starboard are not equal the alignment is not correct. It is considered the shaft should be removed to check contact marks on white metal, and adjusted by scraping if found necessary. This method can also prove the correctness of bush slope. The reason for lifting the tailshaft 0.20 mm at the forward end is not understood, as it is normal to press down at this point and the Author's comments would be appreciated.

Outboard Oil Gland Seal (page 21)

In Fig. 6.12 a pre-machined shoulder is shown in propeller boss. A word of caution is required here as the two dip sticks top and bottom should also be used to confirm that "B" is in fact in a centralized position, and it is only by this means that the seal manufacturers centre line tolerances can be accurately checked. The machining of the propeller boss recess is not always accurate. Failure to check this point could lead to excessive oil leakage at the gland, due to the eccentric motion of the sleeve, should this not be central.

Fitting of propeller and pilgrim nut (page 22)

With the extreme climatic conditions prevailing it is rather surprising that even in 1968 a grease gun was used for the application of pressure. It is also of interest to know if troubles were experienced in threading the nut to the shaft. Unless special gear is made for this, the threads can be subjected to severe damage. Could the Author please state whether special arrangements were made for the handling of the nut.

Alignment (page 30)

It is noted that a strain gauge technique is used during the sea trials to determine if the alignment is satisfactory.

In some yards during the initial stages of the shaft alignment, strain gauges are used to measure the reaction of each bearing in addition to the load measuring by the jack up method. Could the Author confirm whether similar arrangements were made in the case referred to, and is the strain gauge method used only for selected cases. As an additional matter of interest, when attending sea trials it was my practice to ask for the cooling water to be shut off at the intermediate shaft bearings, and in all cases shipbuilders have been agreeable to do this. It was then interesting to find out if there was any variation in bearing temperatures. However, whether an alignment was carried out by the fair curve alignment or straight alignment system no appreciable differences could be detected.

(Page 37)

It is considered that the particular design of turbine has to be considered when aligning is being carried out, as in one design the condenser is attached to a rigid frame so that the water content does not come into the equation. The crossover pipe in this case from the H.P. to L.P. turbine is also neglected from the aspect of thermal expansion.

Boilers (page 39)

It may be of interest that some shipbuilders elsewhere deliver the boilers complete even with the drum and superheater pressure pipes connected.

Bilges (page 53)

As the Author has indicated, the question of "What is accessible?" is often raised. But with the arrangements prevailing at modern shipyards this should be resolved prior to any bilge pipes being fitted. In many ships the space around the screwshaft gland, and bilge space is very limited. I have personally found the shipyards very co-operative provided early notice is given of recommendations. Access around the shaft gland and to bilge well adjacent to the aft peak bulkhead, I have always considered important, and have in the majority of cases been able to achieve a satisfactory arrangement.

Lubricating Oil Lines (page 57)

It is noted that in general the lubricating oil lines are constructed of galvanized steel. In my experience this is a most unusual procedure although I could understand the reason for lubricating oil vent pipes being galvanized. It may be that the yard concerned has some special reason for this procedure as a result of past experience. If so, it would be of interest to know what this was. The practice of fitting a dehydrator to the main gear case is worthy of consideration.

Oil Fuel

It may be of interest to know that in some modern yards, the fuel oil lines, as in the case of feed and steam lines, are welded together having flanged connections only at the connection to pumps and heaters, etc. In the case of feed and steam lines this is very valuable, in greatly reducing problems associated with leakages, while for the fuel lines, the fire risk, the seafarers deadly enemy, is greatly reduced, as special protection can easily be provided, when there is a limited number of flanges.

Rudder Stock and Tiller

A number of the large shipyards do not recommend fitting split tillers on stocks of diameters above 450 mm and in one case above 300 mm in view of the troubles associated with this design. Of course, should owners specify this arrangement they will comply. I fully agree with the opinion of these shipbuilders that the same principles as applied to the keyless propeller should be used on the large diameter rudder stocks, by the fitting of the solid type tiller.

Quay Trials (page 76)

I would suggest one other very important item, namely lubricating oil filters, should be examined prior to proceeding on sea trials, assuming of course that up to this moment extremely fine mesh filters are fitted, and if the filters indicate clean conditions all is well to proceed. The special filters being then replaced with the standard design which of course is of fine mesh.

Post Sea Trials

In some cases bilge pumps and feed pumps used during the period prior to sea trials are opened up for examination. It has been known for impellers to be found damaged. Bilge mud boxes should also be dealt with.

Of particular interest to the Surveyors—Stern Tube (page 12)

Fig. 6.4 indicates a rather abrupt change of section at the joint between the casting and plate. Problems of cracking in this area have been experienced in other yards, but these were resolved by having a good tapered section from the casting to the plate joint over a distance of approximately 6 inches.

In accordance with Rule requirements it is only necessary to have means for measuring the oil temperature of the stern bush oil. Many shipbuilders do, however, fit temperature probes into the bush to within 6 mm of the bore. In my experience one particular shipbuilder was saved considerable trouble and expenses when at the beginning of the dock trials the forward bush temperature rose very quickly, as a result of which there was sufficient time to take corrective measures by slowing down the main engine. To cut a long story short, full power sea trials were subsequently carried out and the bearing temperatures were normal. After the sea trials the shaft was drawn and the forward bush was found wiped and only required a little scraping. The shaft was replaced and subsequently all proved well. Everyone concerned agreed that this early warning saved the day.

Oil Glands (page 21)

Outboard Oil Gland Seal. It may be of interest to know that one shipyard fits a 10 mm oil supply to the oil annulus space "D". This connection is made top and bottom through 10 mm bore copper piping led through the top and bottom oil ways on the outer side of the bush. The pipes are joined to a small header tank in the Engine Room the bottom of the tank being 800 mm above the shaft centre line.

The cooling is obtained by natural circulation, and has proved very successful, seals examined at subsequent dry dockings being found good.

A note about Wear Down

It is suggested that the shaft clearance for an 800 mm diameter shaft as indicated is rather near the bone and clearance of 1,1 mm minimum is considered to be desirable. In my experience with this type of bush over the past decade, clearances have worked out at 1·25–1·75 thousands per inch diameter of shaft. In the case of the ship referred to above which suffered overheating, the clearance was a little below the above minimum.

Over the years departures have been made with the arrangement of the oil ways, some ships having the outside of the bush clear of oil ways and machining three oil ways in the bore of the bush at 60° to one another. Quite recently difficulties were experienced in a high powered triple screw container ship where bearing temperatures were somewhat high on the wing bushes. It was considered that this was due to the wing shafts rising and rotating in the position of the side oil ways, the edge of the corner of the oil groove then breaking the oil film between shaft and bearing surface. New bushes were fitted with the grooves at the 10.30 and 1.30 o'clock positions, and subsequently proved satisfactory. With this arrangement, increased bearing surfaces could be obtained. The latest proposals are that the oil groove be only at the 12 o'clock position, and this could help to reduce further, some of the vibration problems experienced from time to time and the shaft would not juxtapose port and starboard in the oil ways.

Emergency Generator (page 73)

In my opinion if an emergency generator is fitted it should be used as such and nothing else. It is the last line of defence, should the ship's main generators fail. Particularly with the VLCC's of today with so much at stake. In my opinion an emergency generator to be of use, should be of such capacity as to maintain essential services and to allow a ship to proceed and maintain steerage way. Other services which could be considered, e.g. when fumigation is carried out, the emergency generator could be used as a first start up set, or as a first start up set after a prolonged lay up period, which would also serve to prove the set was in working order.

Quay Trials (page 76)

A word of caution is indicated here regarding the disconnecting of the propeller shaft for the purpose of carrying out Quay Trials. Whilst in the case of turbines the case of damage as a result of overspeeding is remote, it is not to be recommended that this procedure be adopted with the large main diesel engines.

There has been over the last few years several cases of serious overspeeding and one must realise that with overspeeding the damage is done in a matter of seconds, not minutes. In one case the main engine had to be removed from the ship for renewal of the crankshaft and other parts. At this particular stage the ship was preparing to go on sea trials. In this case the engine was being operated from the control room and one can well imagine the feeling of the man on the controls when after first starting the engine on air, he immediately started to pull back the fuel lever, and found that instead of the revolutions dropping they were increasing very rapidly. The main engine stopped when the cast iron centre piece of the camshaft gear drive fractured. Since this episode, all shipyards in the country concerned have ceased carrying out dockyard trials on large main diesels with main shafts disconnected.

NOTE.—In recent years some of the large slow speed main engine drives are now being fitted with overspeed cutouts independent of the engine governor.

Sea Trials—Full Astern (page 77)

I fully agree with the Author's remarks and in my experience, shipbuilders who are also engine builders are quite happy to carry out the so-called crash astern test, at a moderate rate. I know of one shipbuilder who carried out two trials (diesel engine), the first rapid when all instruments, and ladders, etc., were shaking violently, while in the second trial the engine was put astern rapidly, but in this case the astern revolutions were held at about 30 rpm. In the latter case the propeller acted as a very good brake, and as the way on the ship eased the revolutions of course increased slowly without touching the fuel lever, until such times as the way on the ship had dropped sufficiently when the fuel lever was adjusted to increase the revolutions. The quietness of the engine was very noticeable during this period. From memory the time factor between ahead and astern motion of the ship was, if anything, in favour of the latter procedure.

This paper covers such a wide field that one could make many more comments but it is felt with other colleagues' contributions most essential points will be covered.

MR. J. C. KARELSE (Amsterdam)

I should like to congratulate the Author and thank him for putting down his experience on these particular installations. I should be very glad to have his opinion regarding the following points.

Should not the Classification Society recommend a bearing load calculation on this type of shafting where the main gear in most cases is 3,5 up to 5 mm below the zero line of the sternbush? In several cases I saw very large differences in bearing load between ballast and loaded condition with total changes on main gear bearings.

What is the Author's preference regarding level gauges? Should they be visible from firing platform or from control room windows?

Is the actual test of the "low level" water cut-out a common practice?

Is blowing through (with steam) of fabricated h.p. steam piping a general practice?

What is the Author's practice regarding testing of float-alarms in fuel oil, feed, lubricating oil and daytanks? (Electrical alarm systems are mostly completed in a very late state.)

Should it not be a Rule requirement to have the "failure of opening" alarm of the astern guardian valve positioned on the bridge console?

I fully agree with the Author's opinion regarding the crash stop.

With alignment gaps in the couplings of the main shafting we had on several occasions difficulties to bring in the coupling bolts (straight type) with heavy fits. From later surveys I heard that they work considerably in this type of shafting with gearing approximately 4,5 mm down. Now a type of bolt is used which is hydraulically stretched during fitting. I should be very glad to hear the Author's experience on this subject.

Finally, I should like to draw the attention of colleagues to any pipeline in the control room, because I overlooked this on one occasion with S.W. lines of an air conditioning unit, which caused a failure of a mimic board and alarm.

Mr. P. KOLLER

The following comments were prompted by the sections in the paper dealing with the main reduction gear alignment.

It is generally recognised these days that ships seatings cannot provide the rigidity ncessary to maintain absolute alignment between main reduction gear elements.

Manufacturers must either choose support areas which will not in themselves influence gear alignment greatly or alternatively ensure that the local ship's structure seating and gearcase together are adequately stiff to avoid excessive gearcase distortion with working of the ship's hull when under way.

Stal Laval have a four area support which takes the weight of the main wheel on two areas of the centre whilst the torque reaction is carried by two areas at the side of the gearcase. The flexibility of the gearcase allows, to some extent, the pinions to align themselves and as described in the paper by spring loading the corners, the means to adjust, to some degree, the tooth contact markings. Has the Author ever been involved with a vessel where gear tooth markings following full power sea trials were not considered satisfactory and further adjustments of the corner springs made to obtain the specified gear tooth contact length.

In contrast another manufacturer G.E.C. Turbine Generators Ltd. (previously A.E.I. Turbine Generators Ltd.) have adopted a single piece fabricated gearcase of a more conventional stiffness with supports at three local areas, i.e. to approximate to a kinematic three point support. The main wheel is underslung and with its weight carried at the sides no direct support is required under the shaft. This construction allows the development of the stiffest possible combined turbine, gear and thrust seating. The single piece gearcase represents an optimum solution to gearcase design with interacting forces maintained within the one rigid structure.

Typical gearcase stiffnesses including bearing oil films, are of the order of 10^7 lb/in. A measure of flexibility is unavoidable and may contribute to a uniform distribution of the tooth load across the gear face width. A gearcase structure with a total stiffness of 10^9 lb/in might present too harsh an environment for the gear elements.

To provide a means of adjusting the gear tooth contacts on erection or following no-load shop trials, adjustable bearing housings are incorporated. These housings, whose positions are determined by adjustable packing pieces which are placed in between the housing and gearcase were originally designed for C.O.S.A.G. Naval gears.

Once a satisfactory gear mesh is obtained and shop trials completed the pinions and primary wheel teeth are coated with a thin layer of Talbot blue lacquer marking, which is impervious to oil, before dispatch and installation at the shipyard. Further adjustment is seldom necessary.

Mr. H. CAPPER

There are one or two aspects of paragraph 9(a) which I consider require clarification. The Author suggests that stainless steel (En 57) is a traditional material for lubricating oil cooler tubes. I would regard such a material as far from traditional and certainly not suitable for such a service. Aluminium brass would be considered traditional and is reasonably satisfactory. Aluminium bronze pipes are also mentioned. This material is an alloy of copper, aluminium, nickel and iron and very difficult to produce in the form of a tube; it is very different from aluminium brass which is an alloy of copper and zinc with a small amount of aluminium added and which is readily available in tubular form.

The taper pins for butterfly valves are often wrongly made of stainless steel. This material suffers from preferential attack in sea water in a bronze valve disc, as is clearly shown in the plates 9.1 and 9.2 in the paper. The correct material for these pins is monel metal but aluminium bronze would also prove serviceable.

Mr. K. LARSEN (Odense)

Mr. Hague has written a very interesting paper containing a wealth of information and no doubt covering most of the practical aspects concerning turbine tanker machinery installations.

Regarding the use of control equipment on shipboard, it is mentioned on page 66 that it is the outlay of money which determines the quality of the equipment and that the shipowner or yard tend to forget this and at times expect too much. I do not think it is unreasonable for the owner or yard to require that the control equipment put on board ships is used to its maximum capacity and according to the brochures most automation equipment is both of a good design and absolutely reliable. According to our instructions the Surveyors should satisfy themselves that the application of components is suitable for the marine conditions and that suitable type testing has been carried out, but in large installations with a number of different components this could easily become a very complicated matter. Would it not be of advantage if it

simply was requested that only essential automation equipment listed by a nationally recognised testing laboratory or selected from L.R's list of approved control equipment should be permitted for use in ships holding the UMS notation.

Reference has also been made to the installation tests on automation equipment being as realistic as possible. In this connection it may be worthwhile mentioning the Standardization Code for Trials and Testing of New Ships issued by the Association of Ship Technical Societies in Norway where detailed information on testing control systems may be found.

Mr. Hague's remarks on page 30 regarding parallel shaft gear examinations are concurred with. The acceptance in the light of 90 per cent tooth contact across the effective face width is always done with some hesitation as the revealed marking pattern usually is somewhat doubtful. When calculating the tooth loading, it is assumed that the load is uniformly distributed across the face width but even with the best attainable surface finish it is normally not possible to avoid asperities carrying the load and thereby reducing the contact area. However, if the gears have been running quietly at full speed during the trials and there is no evidence of burnished tooth surface it is not likely that there are any errors which would have serious effect on life or load capacity. If the gears are noisy, testing equipment may have to be applied to them to show where the errors lie, but normally this is not the case and the gears are accepted. Some gear engineers are of the opinion that if a further examination of the parallel shaft gears be made say three to four months after the gears have been put into service then a far better marking pattern would be revealed. Maybe it would be of value in the case of future installations to recommend such an examination to be carried out and the results of the examination fed back to the place of installation as an assurance that the gears are still operating satisfactorily and that the area of contact to carry the load as required by the Rules has actually been obtained.

The question regarding push-up loads to be applied in connection with the fitting of keyless propellers mentioned on page 26 has recently been under discussion in the Odense district. A Danish shipowner would like to know whether any experience had been gained as to how much the distance washers had to be machined at subsequent removal of the propeller and re-fitting. In reply he was informed that the normal fitting procedure should be adopted. The start point load should be applied to the propeller and the required axial push-up distance relevant to temperature obtained without the distance ring fitted and the required thickness of the distance ring then gauged. Consequently two propeller fittings will be required at each shaft examination by using distance washers so perhaps more attention should be given to the other method where a distance gauge is used in connection with a copy of the relevant fitting curve.

AUTHOR'S REPLIES

To Mr. Chambers

I thank Mr. Chambers for sparing time to attend and open the Meeting. His remarks concerning shaft alignment and the fact that he had already arranged with the Reports Department to have builders alignment figures on board and with first entry reports was gratifying to hear as correspondence with colleagues around the world had shown this information was needed at major dockings. With great trepidation "I was turned over to the specialists" by Mr. Chambers but found this most interesting to listen to as each specialist amplified points relative to his sphere of work and knowledge.

To Mr. Leach

I am very much in favour of reducing anything except salaries, especially First Entry items as Mr. Leach may remember from the occasion I spent with him in Broadgate House vainly trying to cut down on information in the First Entry format. After some time Mr. Leach relented and divulged the fact that a new format had been produced and gave me a preview of the present First Entry forms. However, I still feel that in the initial stages, as many guidelines and *aide memoirs* as possible should be the order of the day. As proficiency increases so one can dispense with a detailed compilation of data and formulate one's own particular reference schedule. The advice to young Surveyors from Mr. Leach is most apt and pinpoints items that certainly can be overlooked and are invariably needed at later dates when repairs or alterations to the ship are required. I feel that Mr. Leach would be an ideal personality to update Mr. Knowles' paper "Some notes on Engine Reports 1958–59" which would be a tremendous help to all Engineer colleagues throughout the world.

To Mr. Munro

With regard to gear teeth marking, the time actually on full power sea trials is very short. Most of the running at so-called full power is really the economical speed and power for in-service use. This is below the rated design power. As such very little change in bearing pattern appeared to take place. It would be interesting to see teeth rubbings after five years and relate them to the working marks. The coating used has not been improved upon to date. The reliance on glossy high spots to shaded areas carrying slightly lower loading being the order of the day by maker's engineers. The section on cold pull ups of steam lines has been touched upon in replying to Mr. Crawford and it is hoped this is sufficient. Mr. Munro's visits to the ships were very searching and possibly this is why he subsequently became stranded in the engine room lift so many times.

To Mr. Holtum

Mr. Holtum put his finger on a very weak spot in new construction when discussing steam pipeline anchor points and hanging bars. It is extremely difficult, if not impossible, to find drawings of these items in the shipyard. The spring loaded hangers are set on site and merely take the weight of the pipe to give flange bolt hole alignment. At bends a form of slipper and sliding foot is incorporated and once again the position rather randomly chosen. A vast amount of words has been written on this subject as can be seen in most technical libraries and it is hoped the Marine Industry will begin to take the interest in this aspect of steam plant installation that is achieved in the Petro-Chemical Industry, especially in view of the valve and piperun flange and cracking that is occurring.

To Mr. Crawford

The battery in question was to first start or activate the electronic assembly for the burner controls and not for the entire ship. I regret this was not explained more precisely in the paper.

The orifice plates used at all the discharge points to regulate flow and give thermal balance were of a non-ferrous metal and appear to be performing satisfactorily, at the time of the first Special Survey. Whether these would become a surveyable item is unknown at this time, as they are mainly for efficiency. It was interesting to note on one new building that the orifice plate had been omitted from the large bore air conditioning C.W. outlet. When this plant was opened up for testing, various other essential machinery items served by the same sea water pump were starved of cooling media and subsequently overheated and failed. Regarding the fuel oil system piping, the lines are fitted with spade blanks at heaters and filters. The relief devices are tested on completion. I should like to thank Mr. Crawford for carrying several of the points further and so giving a fuller explanation.

To Mr. Bolding

I would agree with Mr. Bolding that testing should be with as few people on board as possible. If the yard agreed to do this in the early hours of the morning, which I doubt due to overtime rates being high, I feel sure that most of the Surveyors and Owners' Superintendents' working life would be spent on the night and day shift as automation increased daily.

The reason for the oil and water passing through filters and driers is unknown. Although there are two sets of everything, only one is on line at any one time. Graphite lubricated compressors would appear to be the answer if only their cost would come down. It would be admirable to have duplicate air driers written into the Rules as suggested.

The surveying of the equipment for a UMS notation is painstakingly laborious. An open mind and a closed mouth are the only aids to an engineer, trained in heavy engineering together with a fair share of basic common sense which may be lacking in pure electronic engineers or designers sent to the yard.

The location of fire detector heads and their correct siting is carefully checked during sea trials with the aid of smoke appliances and stroboscope lamps flickering at flame frequencies.

I should like to thank Mr. Bolding for his pertinent questions and his suggestion of Rule additions.

To Mr. Manson

My thanks to Mr. Manson for making the time and effort in replying so fully to the paper. The subject fulfills my request to colleagues to add for the benefit of the bewildered in far off places.

Fitting of Sternbush

The coatings tried on the bush surfaces before push up were oil and "Bahdal". The molycote was washed out during flushing of the stern gland system with a cleasing flushing oil. The 20 tons load were recorded at the final few millimetres stage.

Fitting of Tailshaft

The small lift at the forward end of the tailshaft is merely to ensure that unnecessary crushing of the fresh bearing surface is obviated when using coarse thread jacking arrangements during initial alignment.

Fitting of Prop and Pilgrim Nut

A cradle or sling is used around the nut to enable a start to be caught on the thread.

Alignment

The use of strain gauges on the shaft has been mentioned in the relevant section but only in passing so to speak. It has only been used on the first of each type series to date also practical confirmation of theoretical or calculated loads.

To Mr. Karelse

Mr. Karelse's question on water level gauges and their location is most interesting. I would personally recommend viewing possibilities from the control room. The new breed of marine engineer would appear loathe to leave the coolness of the control room so I am told by Company Engineer Superintendents.

The actual test of all boiler cut-outs should be practical rather than simulated by bridging electronics or wiring. The fires would be out at the time of course. Blowing through of h.p. steam lines is normally carried out with h.p. air in the initial stages. At a later date manœuvring valve filters are opened and cleaned of new construction debris that may have been missed by the air blow through.

Taper shank bolts fitting reamered tapered flange holes have been used here and aid pull up. They are very easy to disconnect at tailshaft surveys.

The float alarms are tested at quite a late date but before the ropes are cast-off for sea trials. Pollution in the dock is easier to contain than at sea.

With regard to the astern guardian valve alarm, this question could be best answered by the Rule Development Department at Headquarters. The present thinking is that anything that detracts from pure navigational aids should be omitted from Bridge Console.

To Mr. Koller

Mr. Koller's question regarding gear teeth alignment and contact was noted with interest. Has he also been involved in the tedious job of re-loading and testing gearing after sea trials are supposedly over, I wonder. The use of a named lacquer marking is most interesting and its suitability will be noted with interest at future examinations.

To Mr. Capper

Mr. Capper's statement, "the taper pins for butterfly valves are often wrongly made of stainless steel", is rather disturbing. I am of the opinion that not all mixes of so-called "stainless" steel are unsuitable and suffer from preferential attack in sea water. Our particular problem occurred through contaminated sea water in harbour areas or industrial waterways. With the larger V.L.C.C. remaining out in open water this contamination may decrease. The theory that the bubbles formed by the fairly flat face of the bulbous bow assembly travel down the ship side and become trapped in suction areas and add to corrosion problems is becoming more popular with Owner's Superintendents as ship side valves are being opened up on their vessels on the same traditional routes with a bulbous bow being the only change in hull form and corrosion being more evident.

To Mr. Larsen

Mr. Larsen's point concerning automation equipment only being selected from a recognised testing laboratory is most welcomed and must become mandatory in the future, I feel sure, due to the persistent increase in automation faults recorded by Owner's Engineer Superintendents with subsequent ship charter down time at high money rates.

Many thanks to my colleague and friend Mr. Larsen for finding the time to expand further a few of the items dealt with in the body of the paper.

I should like to thank all those colleagues who made the effort to attend the reading of my paper and for the friendly reception and gratifying turnout at the Institute Lecture Auditorium that evening.

Incidentally, it was pleasant to notice that the integration of oil and water appears to be taking place by the presence of Hull colleagues. The wit and erudite explanations of some of the hull assembly problems was easily followed and aptly explained by my friend and colleague Mr. David Nicholas.

In conclusion I should like to say to colleagues contemplating putting their knowledge on to paper in the form of a Technical Staff Association Paper; one is not alone in the task. The editing which is most cunningly carried out to quite a professional standard by Mr. C. Cummins is a safeguard against literary boobs, and systematic vetting of each section by senior colleagues, against the majority of technical blunders. The final assembly being put together decoratively by the Printing House specialists. At the end one wonders just what part did one have in the compilation of the final offering as the process is so smooth and professional. I am indeed grateful to them.

Printed by Lloyd's Register of Shipping at Garrett House, Manor Royal, Crawley, Sussex, RH10 2QN, England.